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DUNEDIN CITY COUNCIL

Tahuna Wastewater Treatment Plant Performance Assessment

Submitted to:
Dunedin City Council
Otago Regional Council

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REPORT

Golder Associates

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1.0 INTRODUCTION

1.1 Background

The Tahuna wastewater treatment plant (WWTP) services the city of Dunedin. The WWTP was upgraded from a primary sedimentation to advanced secondary treatment system with UV disinfection and a new 1.1 km ocean outfall to replace a former outfall at Lawyers Head. The upgraded Tahuna WWTP has been fully operational since February 2013.

Dunedin City Council (DCC) holds a number of resource consents from Otago Regional Council relating to the operation of the Tahuna WWTP. A number of the consents require monitoring to be undertaken while others authorise infrastructure (e.g. the ocean outfall) associated with the WWTP. A summary of the consents held by DCC is provided in Table 1 and a copy of the exercised consents is provided in Appendix A.

Table 1: Tahuna wastewater treatment plant consents.

ORC Consent Number	Activity
Tahuna (primary discharge)	
2002.621	Coastal permit to occupy coastal marine area
2002.623	Discharge to water
RM123190V1	Discharge to air
Lawyers Head (contingency)	
2002.624	Discharge to water
2002.626	Discharge to air
2006.534	Coastal permit to occupy coastal marine area
Musselburgh	
2006.825	Discharge to air from pump station generators

DCC has advised that the Lawyers Head (contingency) discharge consents have not been exercised since the commissioning of the new ocean outfall. Consents 2002.621 and 2006.534 have no monitoring or reporting requirements. These consents are therefore not considered further in this report.

The monitoring aspects (relevant to this report) that are covered in each consent are:

- Wastewater Flows and Quality Monitoring
- Contact Recreation Water Quality Monitoring
- Microbiological and Metal Testing of Shellfish
- Biological Rocky Shore Monitoring
- Whole Effluent Toxicity Monitoring
- Sub tidal sediments and Benthic Monitoring
- Air Discharge Monitoring

1.2 Report Purpose

The purpose of this report is to satisfy the requirements of Condition 14 of Consent 2002.623 which states:

> *(a) At the 3rd anniversary of the first exercise of this consent, and every five years thereafter, the consent holder shall undertake a comprehensive assessment of the wastewater discharge to*

determine options for, and appropriateness of upgrading treatment and disposal processes. In undertaking this assessment, the consent holder shall consider, but not limited to the following:

i. *the results and associated assessment of monitoring undertaken in accordance with all the resource consents associated with the Tahuna Wastewater Treatment Plant, including the: Wastewater Quality Monitoring; Contact Recreation Water Quality Monitoring; Microbiological and Metal Testing of Shellfish; Biological Rocky Shore Monitoring; Whole Effluent Toxicity Monitoring; Sub tidal sediments and Benthic Monitoring; and Air Discharge Monitoring.*
ii. *technological changes and advances that may be applicable to the ongoing operation of the plant*
iii. *ongoing compliance with all the resource consents associated with the Tahuna Wastewater Treatment Plant*
iv. *the implications of policy and legislative change of relevance to the ongoing operation of the plant*
v. *the cost of any upgrade options, in the context of the Long Term Council Community Plan*
vi. *any changes to the waste stream entering the Tahuna Wastewater Treatment Plant.*

(b) *In preparing the report, the consent holder shall consult with Iwi, the Liaison Group and the Consent Authority and assess the issues raised during consultation.*

(c) *The consent holder shall submit a report to the Consent Authority by 30 September in the year that the assessment is undertaken. The report shall outline, but not be limited to, the following information:*

- *the report preparation process*
- *issues considered*
- *the outcome of the assessment*
- *implementation stages and associated timing of any proposed upgrade*
- *implications with regards to any existing resource consent conditions*
- *comment on each of the points in Condition 14(a), as a minimum*

Note that under Condition 14(a)iii, compliance with the conditions attached to Resource Consent RM123190V1 and 2006.825 is also documented in this report (Section 6.0). All other conditions referred to in this report relate to consent 2002.623.

This is the first report prepared in accordance with Condition 14. The next report will fall due in five years, in 2021. In addition to satisfying the requirements of Condition 14, this report reviews the consent conditions themselves, with a view to identifying the purpose of the monitoring data in evaluating the effectiveness of the WWTP and any environmental effects, and simplifying and streamlining those conditions where possible.

1.3 Report Approach

In order to satisfy the requirements of Condition 14, the preparation of this report is the culmination of a four stage process to assess the performance of the Tahuna WWTP.

Stage 1 comprised a review of all monitoring data collected by DCC in association with consents held for the Tahuna WWTP. The purpose of this data review was threefold:

- To confirm that the monitoring frequency and parameters analysed met the consent condition requirements

- To assess compliance of monitoring data against specified consent limits
- To provide initial comment on whether the data indicated that the discharge from the Tahuna WWTP was having an adverse effect on the receiving environment

The outcome of Stage 1 was conveyed in a letter report to DCC (included for completeness in Appendix B). The initial data review has been extended as part of Stage 2, which assessed whether the monitoring is appropriate for addressing the effects of the discharge on the receiving environment, and if not, what the alternatives might be. Stage 2 also included recommendations on any improvements that could be made to the drafting of consent conditions. Stage 1 and 2 is reported in sections 2.0 - 6.0 of this report.

Consultation with iwi and the stakeholder liaison group was completed as part of Stage 3. This comprised sending out a letter and flyer summarising the initial findings of the Stage 1 data review. Feedback from stakeholders is reported in Section 7.0 of this report.

This report comprises Stage 4 of the process and in addition to presenting the outcomes of Stages 1 – 3, fulfils the reporting requirements for condition 14, listed in Section 1.2.

2.0 WASTEWATER QUALITY

2.1 Introduction

Condition 14(a)(i) requires assessment of all monitoring data collected in accordance with requirements of all consents associated with the Tahuna WWTP.

2.2 Wastewater Discharge Flows

2.2.1 Monitoring requirements and purpose

Treated wastewater discharge monitoring is required under the following conditions:

- Condition 1 (a)(b), which requires flow monitoring to meet specific flow requirements
- Condition 3, which requires that monitoring be carried out to meet specific discharge quality criteria
- Condition 5 ,which requires DCC keep a continuous record of discharge flow, undertake fortnightly sampling to meet the requirements of Condition 3 and undertake six monthly sampling to measure a range of contaminants

The purpose of flow conditions is to ensure that discharge volumes remain within consented limits. The limits relate to the range of flows that the environmental assessment the resource consent was granted for were based upon.

2.2.2 Wastewater volumes and rates

Condition 5(a) requires that DCC measure flow on a continuous basis. ORC annual consent audit reports (e.g., for 2013, 2014 and 2015) confirm that DCC maintain a continuous record of wastewater flows.

Conditions 1(a)(b) require that:

a. The flow rate of wastewater discharged shall not exceed 600 litres per second average dry weather flow and up to 4000 litres per second peak wet weather flow of treated wastewater.

b. The maximum flow specified in this consent shall not be exceeded except when any exceedance is due to the effects of heavy rainfall (defined as a 1 in 2 year return period 24 hours rainfall event).

Flow information provided by DCC as part of this review consisted of tabulated average daily flow rates in L/s or m^3/d. This information was provided for the period 2012 to 2016. Continuous flow data/records were not provided or sighted. As such comments provided below are based on the limited data summary provided.

A comparison of the average daily flows with the compliance limit of 600 L/s (average dry weather flow) requires information on whether the flows on any given day in the month are "dry weather flows". A comparison of the average flow indicates that there have been exceedances of the average dry weather flow limit in some years (e.g., 10 days in the 2014-2015 year and seven days up to February in the 2015-2016 year). Condition 1(b) (above) notes that the flows can be exceeded due to the effects of rainfall defined as a 1 in 2 year return period 24 hour rainfall event. ORC have identified exceedances of the dry weather low flow limit in their audit reports, noting that some exceedances coincide with significant rain events. The linkage to rainfall for other events was not noted.

Exceedance of the 4,000 L/s compliance limit could not be assessed based upon the summarised flow data that had been provided as the compliance is linked to peak instantaneous wet weather flow. This information will only be obtainable from the continuous flow record. Extreme discharge flows from the WWTP are very uncommon. On 4-5 June 2015 (when a significant rainfall event occurred), total daily flows reached 262,687 m^3. This corresponds to an average (not peak) flow of about 3,000 L/s. No wet weather peak exceedances were identified in the 2013, 2015 and 2016 ORC audit reports.

In summary, discharge flows occasionally exceed the consented 600 L/s average dry weather flows. This is assumed to be due to stormwater run-off although groundwater infiltration may also be a factor. Exceedance of the 4,000 L/s wet weather flow limit could not be assessed in detail, as this would require access to the continuous flow record, however no exceedances were identified in the 2013, 2015 and 2016 ORC audit reports.

2.2.3 Recommendations

Golder recommends that DCC undertakes a further review of the continuous flow dataset and local rainfall records to identify the frequency of exceedances that can be attributed to significant rainfall events.

2.3 Wastewater Influent Quality

2.3.1 Purpose

DCC has undertaken monitoring of influent water quality on a voluntary basis as the sampling and testing is not specified in the consent. Condition 6(a)(vi) does however require that the five yearly report identifies any changes in the waste stream entering the Tahuna WWTP. The purpose of voluntary sampling and testing is to confirm that the influent quality is as expected (as significant variation can have adverse effects on the treatment processes and discharge quality at the plant).

2.3.2 Comments on recent data

Influent quality data were available for the period July 2012 through April 2016. This period includes the year prior to the upgrade. Monitoring includes the collection of samples:

- Every two weeks for the analysis of a wide range of core wastewater parameters (e.g., see Chapter 14 in Ray et al. 2002).
- Every two to four weeks up to July 2013 for the analysis of trace elements including chromium 3^+. After July 2013, analysis of trace elements was discontinued but chromium 3^+ analysis was continued on a three monthly basis.

An examination of the influent data indicates:

- The concentrations of each of the trace element concentrations measured were, with one exception, consistent over the monitoring period. Trace element concentrations in the sample collected on 4 December 2012 were five to 10 times higher than expected in typical influent to the WWTP. The

sample collected on 4 December 2012 also contained five to 10 times the typical total suspended solids (TSS), five day carbonaceous biochemical oxygen demand (BOD_5) (referred to just as BOD in the remainder of the review), chemical oxygen demand (COD) and aluminium concentration suggesting a significant divergence from typical influent quality. The review is not able to comment on this anomaly in the historical data.

- A visual examination of the data presented on Figure 1 (which also shows the corresponding effluent concentrations where available) did not identified any major step-changes in influent quality. More detailed analysis would be required to check for statistical changes. Any changes, should they be detected, are unlikely to be large.

2.3.3 Recommendations

The following recommendations are made in relation to influent monitoring:

- Discontinuation of aluminium analysis. The influent concentration of aluminium will generally be related to the inorganic component in the TSS. Some variation will also occur depending upon the amount of particulate organic matter in the TSS.
- Consider discontinuing quarterly sampling for chromium $^{3+}$ analysis. We are unsure why chromium $^{3+}$ is specifically identified. Chromium is present as +3 and +6 cations. The +6 cation is the form that generates aquatic toxicity concerns. Total chromium analysis is useful for assessing the total amount of chromium present but to assess the significance requires speciation.
- Trace element analysis should be undertaken every two months to enable DCC to compare influent and effluent water quality and thereby assess WWTP performance.

2.4 Wastewater Effluent Quality

2.4.1 Conditions

Condition 5(c) requires:

The consent holder shall on fortnightly intervals, collect 24 hour composite samples of the treated wastewater before chlorination and prior to discharge into the outfall. For bacteria the sample shall be a single grab sample. The sample shall be analysed for the parameters for which treated wastewater standards have been set in the table in condition 3. This monitoring data shall be forwarded to the Consent Authority every 3 months b 31 March, 30 June, 30 September and 31 December of each year

Table 3 below summarises all parameters required to be measured by Table 3 in condition 5(c) of the consent.

Condition 5(e) requires:

The consent holder shall at six monthly intervals, collect 24-hour composite samples of the treated wastewater before chlorination and prior to discharge into the outfall. The samples shall be analysed for: Antimony, Arsenic, Boron, Cobalt, Manganese, Mercury, Molybdenum, Selenium, Thallium, Vanadium, Formaldehyde, Emulsifiable Oil, Volatile organic compounds, semi - volatile organic compound, phenols, and organotin compounds. The results shall be forwarded to the consent authority by 31 March and 30 September each year.

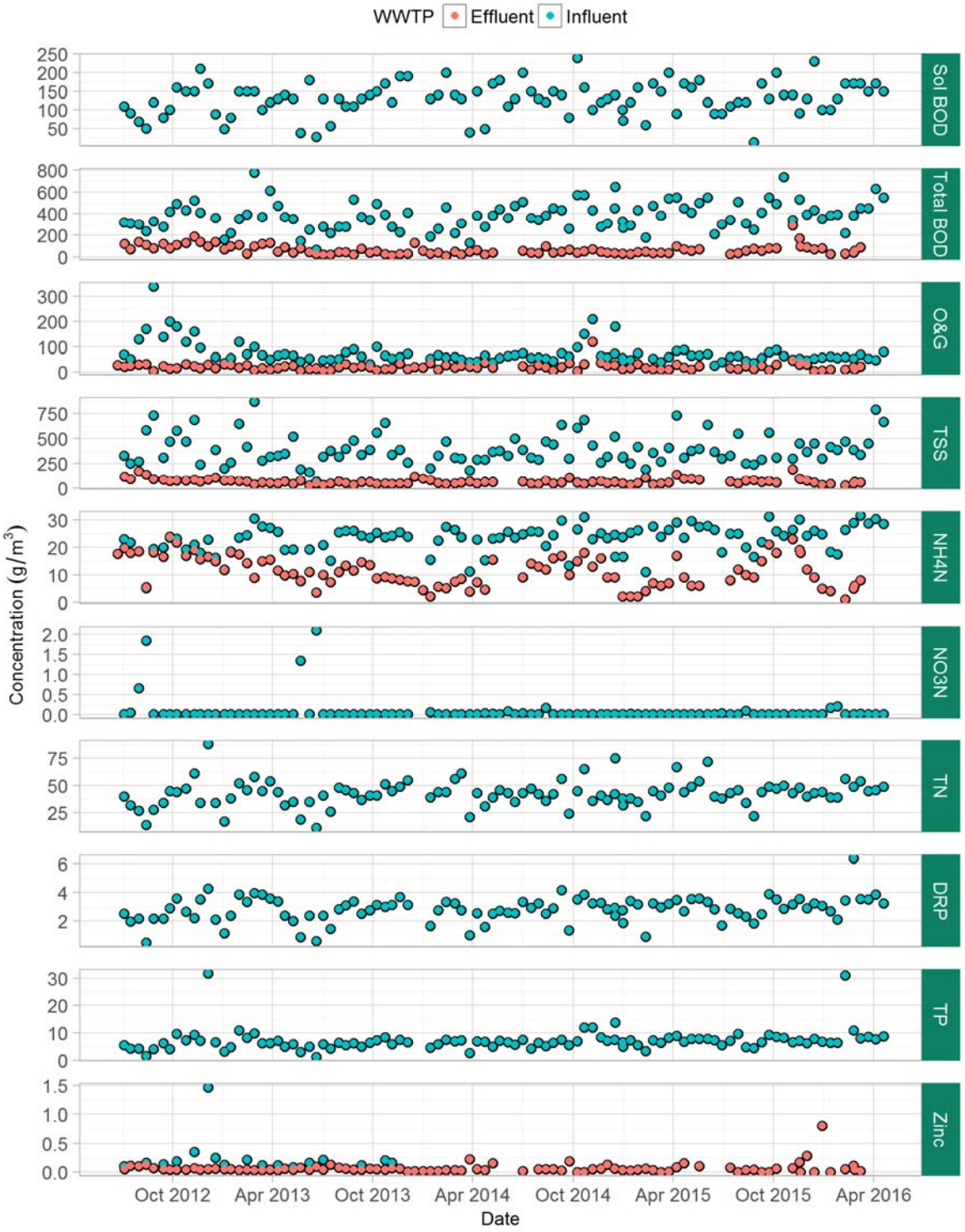

Figure 1: Summary of influent and effluent data for WWTP from 2012 (some outliers excluded).

2.4.2 Fortnightly samples

2.4.2.1 Purpose

The sampling undertaking on a fortnightly basis are 'core' parameters. Core parameters are either measures of plant performance or are parameters that have environmental significance (i.e.,an exceedance may lead to a particular environmental issue).

2.4.2.2 Effluent quality data

Effluent quality data was examined for the period July 2012 through March 2016. The concentrations of the key constituents are shown on Figure 1. Table 2 provides a comparative summary of the influent and effluent concentration data for the monitoring period, and highlights the effectiveness of the WWTP in removing the key constituents relative to the influent.

Table 2: Influent and effluent quality between 2012 and 2016.

Parameter	Influent	Effluent	Change
Total BOD_5	400 (69-1,700) (100)	67 (10-290) (92)	83 % reduction
Oil & Grease	79 (15-260) (99)	21 (4-120) (93)	74 % reduction
TSS	430 (68-2,600) (100)	62 (30-1,90) (92)	86 % reduction
Ammoniacal-nitrogen	23 (3.6-32) (100)	11 (1-24) (100)	52 % reduction
Zinc	0.25 (0.087-1.5) (17)	0.064 (0.0015-0.81) (90)	74 % reduction

Note: All data mg/L unless stated. Data are presented as the mean (range) (number of samples).

Table 3 summarises effluent compliance. Compliance is based on a six month rolling median and 12 month rolling 95 %ile value (the two items identified in each cell in Table 4). The majority of parameters comply with the consent limits. Parameters for which a non-compliance has been recorded are discussed further below. There appear to be some minor inconsistencies in compliance assessment in the ORC audit reports. For example the total copper and zinc non-compliance in the 2014/2015 year.

2.4.2.3 BOD and TSS

BOD and TSS (which, as described before, are linked to some extent) non-compliances have been recorded throughout the monitoring period. Between July 2015 and March 2016 the six monthly median value was consistently higher than the limit of 50 mg/L for both parameters. 16 of 18 individual TSS concentrations were higher than the six monthly rolling median consent limit and 16 of18 BOD results were also above the same limit, resulting in the discharge apparently being non-compliant most of the time. The consent allows only one sample a year to exceed the 12 month 95 %ile limit of 140 mg/L.

Both TSS and BOD are fundamental indicator parameters in WWTP treatment processes. As such, WWTP performance is critical to meeting the consent limits.

2.4.2.4 Oil & Grease

Oil and grease (O&G) concentrations have not complied in the post 2012 data examined as part of this review. As summarised in Table 2, the median concentration of O&G in the influent was 79 mg/L, which is within the range seen for many WWTPs. Metcalf & Eddy (1991) report an average O&G concentration of 70 mg/L (with a range of between 45 mg/L and 100 mg/L) for household O&G. Influent quality has varied somewhat with concentrations above this in early 2012 and then again in the fourth quarter of 2014.

Discharge compliance limits set in the consent condition are 10 mg/L (as a rolling six monthly median concentration) and 30 mg/L (as a 12 month rolling 95 %ile concentration). Final wastewater has had a mean concentration of 21 mg/L since 2012 but the maximum concentration in the discharge has exceeded typical influent concentrations at times. Both compliance limits have been exceeded in each year of data examined. O&G concentrations in treated wastewater vary considerable depending upon the sources contributing and the treatment processes at the WWTP.

Table 3: Summary of year by year compliance for effluent fortnightly sampling.

Parameter	2015/16	2014/15	2013/14	2012/13
pH	Y/Y	Y/Y	Y/Y	Y/Y
BOD	N/N	N/Y	Y/N	N/N
TSS	N/Y	Y/N	Y/N	N/N
Sulfide	-/Y	-/Y	-/Y	-/Y
Oil & grease	N/N	N/N	N/N	N/N
Ammoniacal-N	-/Y	-/Y	-/Y	-/Y
Faecal coliforms	N/N	Y/Y	N/N	N/N
Enterococci	Y/Y	Y/Y	N/N	N/N
Total Al	-/N	-/Y	-/Y	-/Y
Total Cd	-/Y	-/Y	-/Y	-/Y
Total Cr 3^+	-/Y	-/Y	-/Y	-/Y
Total Cr 6^+	-/Y	-/Y	-/Y	-/Y
Total Cu	-/N	-/N	-/Y	-/Y
Total Pb	-/Y	-/Y	-/Y	-/Y
Total Hg	-/Y	-/Y	-/Y	-/Y
Total Ni	-/Y	-/Y	-/Y	-/Y
Total Zn	-/N	-N	-/Y	-/Y
Total Ag	-/Y	-/Y	-/Y	-/Y
Total CN (WAD)	-/Y	-/N	-/N	-/Y

Note: Seasons run from 1 July and 30 June except 2015/16 for which data beyond 31 March are not available; green shaded cells are compliant with respect to both the six month rolling median and 12 month rolling 95 %ile limits (with the compliance defined in this sequence by Y or N in each cell); blue shaded cells are non-compliant with respect to one of the limits and orange shaded cells are non-compliant with respect to both limits.

Fats and oils are contributed by a wide range of sources contributing to the WWTP. These include industries (e.g., food processing and producers storage premises), commercial premises (e.g., restaurants and fast food outlets) and domestic sources (butter, lard, cooking oils, natural compounds in nuts and fats in human wastewater). In addition, a range of man-made oils and greases enter the wastewater system (from a range of industries and premises). More detail can be found in Ray et al. (2002)

The nature of O&G measured is determined by the method used. The most common method is APHA 5220. “Oil and grease’’ is defined as any material recovered as a substance soluble in the solvent. It includes fatty matter from animal and vegetable and other material extracted by the solvent from an acidified sample (such as sulfur compounds, certain organic dyes and chlorophyll).

There are a number of reasons why O&G can be elevated in the final treated wastewater discharge. These include higher influent flows resulting in carry through, higher TSS resulting in emulsified O&G being taken through with TSS. Figure 2 and Figure 3 illustrate the relationship between O&G and the key wastewater constituents, TSS and BOD, for data collected since June 2012. A high proportion of influent O&G show a generally linear relationship with both TSS and BOD_5 (Figure 3). There are a number of samples where elevated concentrations of O&G are evident relative to the other parameter. Effluent O&G concentrations (Figure 4) appear to display a possible relationship to TSS concentration with all samples except one. The

relationship with BOD_5 in the effluent is less distinct. Those years where BOD_5 concentrations were non-compliant do not display higher concentrations of O&G.

Oil and grease that might be present in treated wastewater are important as they have the potential to contribute to slicks and films at the point of discharge (Sections 70, 107 RMA). Historically around New Zealand, in situations where excess O&G was present and passed through to the discharge, fat particles have been recorded on water surfaces or washed up on beaches close to the outfalls.

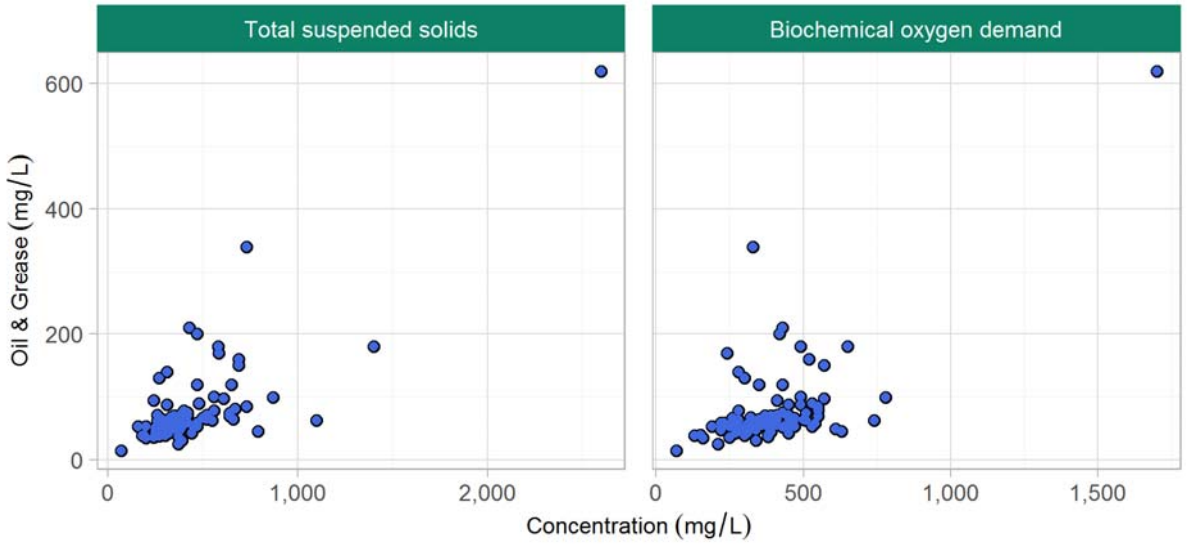

Figure 2: Relationship between Oil & Grease and TSS and BOD_5 in WWTP influent.

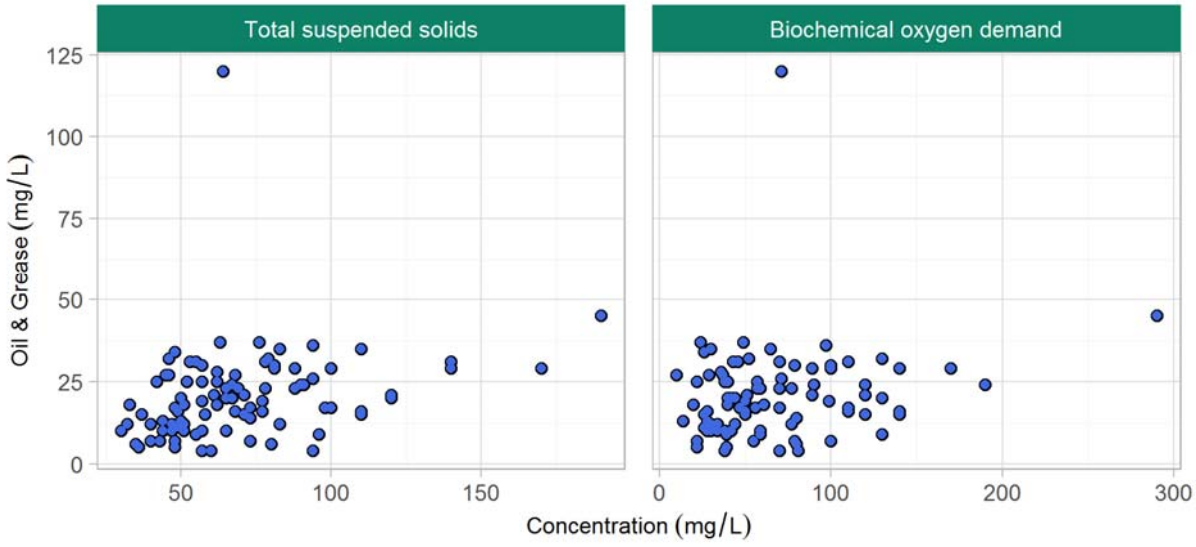

Figure 3: Relationship between Oil & Grease with TSS and BOD_5 in WWTP effluent.

In relation to the WWTP discharge, an examination of available information (in the context of this review) has shown that O&G concentrations rarely rise above 40 mg/L in the final wastewater. Reducing either TSS or BOD_5 through improved treatment is not likely to result in an immediate reduction of O&G in final discharge concentrations. At this stage, a reduction in O&G is likely to occur only through reductions in O&G inputs to

the WWTP or changes to treatment processes to improve O&G removal. Neither scenario has been assessed as part of this review.

O&G control is required to minimise the occurrence of post-discharge slicks and sheens or the generation of fat particles from the discharge. Golder is not aware of whether there have been instances of slicks being identified close to the discharge or fat particle production being identified on shoreline beaches. If there is no evidence of the discharge having resulted in O&G related slicks at the discharge or being responsible for the presence of fat particles at the shore a change to the O&G compliance limit is recommended.

2.4.2.5 Bacterial indicators

Bacterial indicators are a key element of the monitoring program. They are monitored as a surrogate for the possible presence of human pathogenic organisms (viral and bacterial etc. pathogens). Bacterial indicator compliance has improved in the most recent sets of data. Treatment improvements at the WWTP in February 2013 resulted in reduced FC and enterococci counts.

The FC to enterococci ratio has been variable over time. Most samples the FC count exceeds the Enterococci count but in a small proportion of occasions the reverse is true.

2.4.2.6 Total aluminium

Total aluminium concentrations did not comply in the 2015-2016 data set (Table 3). This is not considered to have any environmental significance. The review has not identified where the discharge compliance limit for total aluminium was derived from.

The non-compliance in late 2015, was caused by a single aluminium concentration of 17.1 mg/L that does not appear to be linked to any other unusual parameter data.

2.4.2.7 Chromium

Both chromium 3+ and 6+ are measured in every sample collected. Given that chromium 6+ has not been detected in any sample in recent years, the testing appears redundant. We recommend total chromium (measured as all chromium expressed as +3) should be undertaken.

2.4.2.8 Total copper and zinc

Total copper and total zinc have not met compliance limits at various times over the last two years (Table 3). Prior to the 2013/14 season, total copper and total zinc were compliant. Elevated concentrations of copper that resulted in the compliance limit being exceeded occurred on 21 January 2015 (0.11 mg/L), 21 April 2015 (1.62 mg/L), 0.22 mg/L (27/7/15) and a period of five samples ranging from 0.078 to 0.227 mg/L (7/10/15 to 1/12/15). For zinc the non-compliance resulted from one sample in each annual period being 1.7 mg/L (5/5/15) and 0.808 mg/L (29/12/15). No obvious correlation to any other parameter was evident in the data.

2.4.2.9 Cyanide

Cyanide has met compliance limits in two of the last four years of data that were examined. In those years where the limit was exceeded, this typically occurred in a small number of samples but affected the exceedance for at least six months as total cyanide has a compliance as a 12 month 95th percentile). Given that the ANZECC limit in marine waters for the protection of aquatic biota of 0.02 mg/L, it is unlikely that the exceedance will have environmental implications following reasonable mixing.

2.4.3 Six monthly samples

2.4.3.1 Purpose

The consent requires six monthly analysis of the discharge including ten metals and metalloids plus formaldehyde, emulsifiable oil, organotin compounds, phenols, volatile and semi-volatile compounds (VOC and SVOCs, respectively). Data were only available for the period August 2013 through February 2016 (six samples in total). This type of sampling is often required as a component of WWTP discharge monitoring.

The constituents included in the list of a condition such as this are very dependent upon what environmental matters are discussed at the time that the consent condition is being written and then can often be taken

from a previously published list. Apart from pre-existing concerns regarding elevated concentrations in plant influent or trade waste controls, selected trace elements are typically selected on environmental significance (i.e., to demonstrate that they are not present or are present at expected and low concentrations). An example of the environmental significance of trace elements can be found in Table 10.3 of Ray et al. (2002). In the absence of specific information, SVOC trace level screens are often used as surrogates to confirm that the discharge doesn't contain any unusual organic compounds (in terms of the analytes in the screen).

2.4.3.2 Organic compounds

In relation to the organic compounds in the list:

- Formaldehyde has on no occasion been identified above the detection limit of 0.02 mg/L.
- Phenols have been detected in the last four samples collected but were not detected in the two prior samples (where the detection limit was 0.02 mg/L). Given that the ANZECC (2000) 95 % trigger value for phenol is 0.4 mg/L, the value of including phenol in the monitoring program is unclear. Phenol will also be detected in the SVOC analysis.
- No VOC or SVOCs have been detected in the six samples collected since 2012. Golder has not sighted the laboratory reports to confirm the type of analysis undertaken – to confirm whether the methods used were 'crude' (screen or trace) or capable of detecting concentrations of environmentally significant compounds in the wastewater. In addition, Condition 5(e) requires the collection of a 24 hour composite sample. Golder does not have details of the sample and storage procedures for the collection of the 24 hour composite samples used for this analysis. However, the sampling method would require samples to be manually collected and stored (with no head-space) each sample being used to form the composite sample to avoid loss of volatile compounds. This will be less of an issue for semi-volatile compounds but sampling protocols still need to be followed. Although it is likely that some VOCs will be present in the final discharge, it is recommended that the VOC screen be dropped from the monitoring requirements.
- Formaldehyde is a VOC and, if retained in the analysis program, must be collected in glass using protocols appropriate for VOC compounds.

2.4.3.3 Trace elements

In relation to the metal and metalloid concentration data measured between August 2013 and February 2016, Table 4 provides a recommendation as to whether a parameter should be retained or removed from the programme. The rationale for the recommendation is provided in the recommendations section following the table. The key points relating to the data presented in Table 4 are:

- Trace element concentration data for antimony, arsenic, cobalt, mercury, molybdenum and selenium was generally consistent over time.
- Vanadium and thallium have had variable detection limits on all most analysis occasions which varied by a factor of 100. This reduces the value of the data.
- Boron has been measured at low concentrations. Given that the boron concentration in seawater is about 5 mg/L, there is little environmental implication of low levels of boron in the discharge.

Supporting information relating to the recommendations to remove elements from the monitoring program identified in Table 4 are set out below:

- Note A

  The concentrations of arsenic, antimony, cobalt and vanadium were generally within the range expected in seawater. Mass of contaminants is an important consideration in some environments (depositional environment).

- Note B

  The concentrations of boron and molybdenum were below the concentrations measured in seawater.

- Note C

  Although manganese concentrations are elevated compared to those measured in seawater, it is a common constituent of wastewater (like iron) that poses little environmental risk.

- Note D

  The limit of detection for thallium does not enable the measurement of this element in the final wastewater. Thallium is not typically a contaminant of concern in most WWTP discharges.

- Note E

  Although selenium has been detected at concentrations higher than present in seawater, concentrations will have returned to ambient at the edge of the mixing zone. Concentrations are also well below USEPA chronic criteria.

Table 4: Summary of WWTP effluent trace element concentrations.

Element	Data range (n=6)	Seawater µg/L**	ANZECC (2000) 99 % protection	ANZECC (2000) 95 % protection	USEPA (2009)	Monitoring recommendation (reason)
Arsenic	<1-3	1.5	NG	NG	36/69	Remove (A)
Antimony	<0.42-0.34	0.195	NG	NG	NC	Remove (A)
Boron (mg/L)	<001-0.114, 1.76	4.5	NG	NG	NC	Remove (B)
Cobalt	<0.1 – 0.093	0.0198	0.005	1.0	NC	Remove (A)
Manganese	37.5-104	0.020	NG	NG	NC	Remove (C)
Mercury	<0.08 – 0.13	0.000140	0.1	0.4	0.94/1.8	Retain
Molybdenum	<0.05 – 0.442	9.6	NG	NG	NC	Remove (B)
Selenium	<1 – 5 and 27	0.15	NG	NG	71/290	Remove (E)
Thallium	<0.05 - <2	0.013	NG	NG	NG	Remove (D)
Vanadium	<0.05-8	1.99	50	100	NC	Remove (A)

Notes: All units are µg/L unless stated; USEPA (2009) criteria are for dissolved metals and metalloids. ** MBARI (2016).

2.4.4 Recommendations

A number of recommendations are made to remove a number of parameters from the effluent monitoring required by condition 5. These include:

- Remove aluminium from the routine (fortnightly) effluent monitoring program.
- Remove chromium 3+ from the routine effluent monitoring program.
- Remove the trace elements arsenic, antimony, boron, cobalt, manganese, molybdenum, selenium, thallium and vanadium from the six monthly sampling program required by Condition 5e,
- Remove the formaldehyde, phenol and organo-tin compounds from the list of analytes required by Condition 5e.
- Remove the VOC screen from the six monthly programme but retain the SVOC screen (and ensure that the screen analysis is undertaken at trace level).
- If there is no evidence of the final discharge having resulted in O&G related slicks at the discharge or being responsible for the presence of fat particles at the shore a change to the O&G compliance limit is recommended. This will require a re-evaluation of the last few years O&G data.

Overall, any recommendation to remove an environmentally significant trace element from the discharge monitoring programme needs to be made on the basis that there will be no changes in the nature of influent to the WWTP (e.g., a new industry) or the effectiveness of the WWTP to remove that contaminant.

2.4.5 Annual sampling

2.4.5.1 Purpose

Condition 6(h) requires:

From 1 September 2011 the consent holder shall every year between the months of November and April collect a sample of the wastewater and have it analysed for the following pathogenic micro-organisms outlined below. The sample shall be taken at the time as one of the fortnightly samples required by condition 5(c).

- *Enterovirus*
- *Campylobacter*
- *Salmonella*
- *Giardia*
- *Cryptosporidium*

We have assumed that the annual pathogen sampling was included to provide confirmation of the levels of key pathogens in the discharge. However, the sampling is a single grab in a year and the sampling is not undertaken in relation to any key human health indicator. The presence of human pathogenic organisms in the discharge will be a function of their presence in wastewater entering the WWTP (i.e., the presence of disease in the community).

2.4.5.2 Data obtained

Results for three annual periods (2013-2016) have been sighted and these data are summarised in Table 5. Sampling and testing has been undertaken as required by the consent each year. No campylobacter or salmonella have been detected. Enterovirus numbers were variable and will be dependent upon the health of the "community" in the period prior to sampling.

Table 5: Summary of annual pathogen monitoring results in WWTP discharge.

Date	Campylobacter	Enterovirus	Salmonella	Cryptosporidium	Giardia
	MPN/100 mL	pfu/100 L	MPN/100 mL	Not identified	Not identified
9/02/2016	<1.0	65	<1.0	3	1
24/02/2015	<2	<5	<2	<1	1
11/02/2014	<2	1,200	<2	<1.0	3

To date, the data obtained confirms that a number of pathogens have been detected in the final effluent, as might be expected. Their presence is a reflection of a number of factors and only becomes a concern should illness (e.g., an outbreak of gastroenteritis occur in the community) introduce a very large number of virus to the plant, which then passes a proportion through to the discharge. Such increases then have the potential to result in increases in waterborne virus numbers. Unless the sampling occurs at a point in time coincident with an outbreak, significant changes from normal operating conditions are unlikely to be detected. As such the annual monitoring could be eliminated and replaced with a response sampling event. This is identified as a recommendation for discussion.

2.4.5.3 Recommendations

Golder recommends that the annual pathogen sampling should be replaced with a sampling regime that has a public health focus. The timing of sampling can be targeted either as a response to significant numbers of indicator bacteria in the final discharge or when a notified disease outbreak occurs in the community. The mechanism for either approach needs further development.

2.4.6 Final discharge WETT testing

2.4.6.1 Condition and purpose

Condition 6(e) requires:

The consent holder shall undertake annually in March/April each year a whole effluent toxicity test on representative primary treated and chlorinated wastewater samples. The testing shall be carried out using three separate organisms which are representative of different trophic levels and shall include at least 1 plankton and I macroinvertebrate. The methodology used shall be consistent with the first Whole Effluent Toxicity test undertaken in 2002 by the consent holder (NIWA, August 2002 "Tahuna Wastewater Treatment Plant Upgrade: Effluent Toxicity Testing").

Whole effluent toxicity testing (WETT) provides a useful measure of the integrated toxicity of the final discharge. This is an industry standard test method used at a number of discharges in New Zealand.

2.4.6.2 Annual testing

The NIWA (2002) toxicity testing report has not been sighted to check that current methods are consistent with that report. However, methods identified in the annual testing reports are complete and based on standardised test methods. The testing in the NIWA WETT testing used three organisms (a unicellular marine algae, an estuarine amphipod and blue mussel embryo). All tests used were growth, long term survival or development tests. Reports were available for the years since 2013. The key results of the reports included:

- For 2013 and 2014, worst case dilution requirements as indicated by the amphipod toxicity test indicated the maximum dilution requirement for no toxicity was less than 12 times. Significant abnormal blue mussel embryo development was observed in both years when the effluent was at its highest concentration at the outfall (50 %).
- For 2015, results were similar to previous years with amphipod survival having the greatest dilution requirement for no toxicity (20 times dilution). Amphipods displayed effects on survival and morbidity at 80 % effluent. Blue mussel embryo also displayed reduction in normal embryo development (65.6 % effluent).
- For 2016, results for amphipods were similar to previous years but algae displayed a higher dilution factor required for no toxicity (25 times). The 2016 test indicated no significant toxicity effects on survival or morbidity for amphipods. Significant toxicity was identified at 50 % effluent with 83 % reduction in normal blue mussel embryo development.

Overall, all toxicity tests have shown that dilution available within the outfall mixing zone is sufficient to prevent significant toxicity beyond the edge of the mixing zone.

2.4.6.3 Recommendations

It is recommended that WETT testing continues in accordance with the current condition.

2.5 Wastewater Compliance Statement

In relation to wastewater compliance the following key matters summarise the outcomes of this review:

- The discharge flows occasionally exceed the consent average dry weather flows. This is assumed to be due to stormwater run-off although groundwater infiltration may also be a factor. It was not possible to evaluate peak wet weather exceedances as the continuous data were not available.
- Influent quality is monitored but this is not a compliance requirement. The monitoring provides information on long term influent quality and coupled with effluent quality the effectiveness of the WWTP at removing contaminants. No significant trends in influent quality were identified in the data available since 2012.

- Effluent quality has been monitored as required by the resource consent. Fortnightly sampling since 2012 has shown that nine of 19 parameters with compliance limits had some non-compliance over the period that effluent data was examined (four years). Of the nine parameters, one (total aluminium) had a limit that did not appear to be environmentally based and chromium 6+ appears to be unnecessary due to non-detection. It is recommended that aluminium and chromium 6+ be removed from the monitoring programme.
- Six monthly effluent quality sampling has been carried out as required since 2012 (the dataset provided). Some analysis have been carried out using different detection limits reducing the value of the data collected. Some effluent monitoring is not considered necessary and recommendations have been provided for the removal of these parameters from the monitoring programme.
- Annual pathogen testing has identified pathogens in the final discharge. Some pathogens are expected to be present. However it is recommended that the timing of sampling be altered to require sampling at critical times when pathogens may be present in higher numbers.
- Annual toxicity testing has been carried out as required by the resource consent conditions and no changes are recommended.

3.0 RECEIVING WATER QUALITY

3.1 Monitoring Conditions

In relation to environmental monitoring, condition 6 requires:

6. a) i) The consent holder shall undertake sampling of the following beach water at weekly intervals from 1 November to 31 March (Inclusive) and at monthly intervals from April to October (inclusive). The samples shall be analysed for:

- St Clair Beach - enterococci

- Middle Beach - enterococci

- St Kilda Beach - enterococci

- Lawyers Head Beach - enterococci

- Tomahawk Beach - enterococci

- Tomahawk Beach East - enterococci

- Smails Beach - enterococci

- Sandfly Bay - enterococci

6. a) ii) iii) iv) and v) provide requirements for sampling methods, results assessment and reporting and are not repeated here in full, with the exception of the initial part of iii):

"*The results of the beach water sampling are to be assessed in accordance with the requirements of the Ministry for the Environment and Ministry of Health Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas, June 2003,"*

Condition 6 (d) also requires that:

d) The consent holder shall undertake microbiological monitoring as identified below:

i) Monitoring of faecal coliform levels in both mussel flesh and the coastal waters on four occasions each year. Samples are to be collected from Blackhead, Second Beach, Lawyers Head Beach, Smails Beach,

Boulder Beach, Sandfly Bay North, Sandfly Bay South, Allans Beach and Victory Beach. Hoopers Inlet shall be sampled for water quality only.

It is important to note that the monitoring programme includes a control site at Victory Beach (Wickliffe Bay) that is not potentially influenced by the WWTP discharge. Although final discharge monitoring is undertaken for indicator bacteria, monitoring is undertaken at shoreline shellfish sampling locations to assess whether microbial water contamination has occurred (due to wastewater travelling to shoreline locations). The confounding factors involved are discussed further below and in the following section 4.0.

3.2 Indicator Bacterial Monitoring

3.2.1 Purpose of receiving water quality monitoring

Water quality monitoring required by condition 6 (a) is undertaken for the purpose of:

- Assessing beach water quality where bathing occurs – contact recreation.
- Assessing suitability of water in shellfish areas for the gathering of shellfish.

3.2.2 Bathing water quality

MfE (2003) sets out the microbiological guidance for the assessment and grading of beach water quality where bathing occurs. The data assessed comprised annual spreadsheets of enterococci at the eight sites identified in 6.a) i) and faecal coliforms at two (St Kilda and Lawyers Head). Golder has not assessed the faecal coliform data in the spreadsheets provided.

MfE(2003) identifies the following guidance in relation to enterococci in bathing waters:

- Surveillance/Green Mode: No single sample greater than 140 enterococci/100 mL
- Alert/Amber Mode: Single sample greater than 140 enterococci/100 mL
- Action/Red Mode: Two consecutive single samples (resample within 24 hours of receiving the first sample results, or as soon as is practicable) greater than 280 enterococci/100 mL

The commentary provided below in relation to the enterococci results obtained since 2012 must be considered taking into account all of the provisos set out in MfE (2003):

- During the 2015-16 year, all results were below the green mode threshold.
- During the 2014-15 year, a single sample from Lawyers Head beach was reported at the green threshold (17 December 2014).
- During the 2013-14 year, one alert breach (Tomahawk Beach 22 December 2013) and three action breaches occurred (St Clair 28 February 2014, Lawyers Head beach 8 January 2014 and Tomahawk Beach 14 April 2014). All other samples were below the green mode threshold.
- During the 2012-13 year, a single alert number was identified at Smaills Beach (30 August 2012) and an exceedance of the action threshold at Sandfly Bay (3 January 2013). At Lawyers Head beach, a range of threshold exceedances were identified. Two in late 2012 and then a sequence of exceedances that included on going repeat sampling between early January and early February 2013.

Between June 2012 and March 2016 repeat sampling required by the conditions was carried out. The ORC (2013) audit report attributed the action threshold exceedances in summer 2013 to wildlife sourced bacteria.

Overall, the shoreline enterococci sampling has been undertaken in compliance with the consent condition. Results appear to have been reported as required by the ORC and the conditions. Golder has not assessed sampling methods as these are not described in available documentation.

3.2.3 Shellfish gathering water quality

Seawater faecal coliform data were provided in spreadsheet summary form and in summary reports with shellfish microbiology and trace element concentration data (Ryder 2013 to 2016).

Sampling has been undertaken as required by the consent condition. The consent condition has no specific reporting or compliance assessment component in relation to faecal coliforms in water at shellfish gathering locations. As such, all ORC audit reports make no comment on the results obtained as the results do not trigger any compliance or reporting condition.

Over the period July 2013 through March 2016 faecal coliforms were measured above the guidance value provided by MfE (2003). Given that sampling is carried out every three months, direct comparison with the requirements of MfE (2013) is not possible (i.e., the need to calculate an exceedance based on a shellfish gathering season etc.). A range of samples across the four years exceed both the lower median sampling guidance numeric value (14 MPN/100 mL) and also the higher 10 % exceedance in a shellfish gathering season numeric value (43 MPN/100 mL).

The annual shellfish reports (Ryder 2013 to 2016) discuss the data collected from the shellfish related microbiological monitoring. Golder has provided some comments on the report for the 2015-2016 year (Ryder 2016) as the report provides an overview of microbiological information collected in the monitoring programme:

The background notes that the report sets out results that relate to condition 6(d) noting that "*the purpose of the monitoring programme is to assess the status of coastal faecal contamination with respect to the DCC's coastal wastewater outfalls and other background sources of faecal contamination (e.g. rivers, farm runoff, birds, seals)*".

Section 5.1 of the Ryder reports provides notes regarding MfE (2003) "recreational and marine shellfish gathering waters move to enterococci for recreational waters". This is somewhat confusing as the report does not specifically deal with recreational water quality. The focus is on the recreational gathering of edible shellfish.

The report then identifies that ANZECC (2000) provide guidelines for faecal coliforms for primary contact recreation. ANZECC (2000) specifically identified that in New Zealand, reference should be made to the current recreational water quality guidelines (MfE 2003). As such use of the ANZECC (2000) guidance is in our view not appropriate. Given that DCC runs a bathing beach recreational water quality program using enterococci (as required by MfE 2003), the shellfish reports should not in our view discuss recreational water quality based on faecal coliform data collected for the shellfish gathering programme.

The review has concluded (as has been noted in Ryder reports) that there are multiple sources contributing to shoreline microbiological results. Until the contributing sources are identified, the causal factors in any elevated water bacterial numbers will not be known.

3.3 Receiving Water Compliance Statement

DCC undertakes monitoring for both contact recreational water quality and for shellfish gathering water quality. Based on the information reviewed by Golder, all monitoring has been carried out in compliance with the conditions. As such, information has been collected on both aspects of shoreline microbiological water quality.

There are no reporting or compliance requirements for the shellfish gathering aspects of water quality. Beach quality monitoring using enterococci has shown elevated bacterial counts at times and this has resulted in repeat monitoring as set out in the consent. This sampling and reporting has been compliant.

3.4 Recommendations

DCC currently carries out two sets of water quality microbiological monitoring that to some extent duplicate effort, namely water quality monitoring for shellfish growing suitability and shellfish bacteria in tissue testing. Given the difficulties Ryder has expressed in finding enough suitable shellfish for testing, Golder recommends that the monitoring of bacteria in shellfish tissue could cease. Alternatively, the sampling requirements could be changed such that monitoring of bacteria in shellfish tissue is only required if results of water quality monitoring for shellfish growing suitability exceed guidance values.

4.0 SHELLFISH QUALITY

4.1 Shellfish Microbiological Monitoring

4.1.1 Monitoring requirements and purpose

Condition 6 requires shellfish microbiological monitoring:

d) The consent holder shall undertake microbiological monitoring as identified below:

i) Monitoring of faecal coliform levels in both mussel flesh and the coastal waters on four occasions each year. Samples are to be collected from Blackhead, Second Beach, Lawyers Head Beach, Smaills Beach, Boulder Beach, Sandfly Bay North, Sandfly Bay South, Allans Beach and Victory Beach. Hoopers Inlet shall be sampled for water quality only.

iii) Monitoring of enteroviruses in mussel flesh on two occasions each year between the months of October-November and April-May. Sampling is to be undertaken in conjunction with the faecal coliform monitoring outlined in (i) above. Samples are to be collected from Blackhead, Second Beach, Lawyers Head Beach, Boulder Beach and Victory Beach.

The results of the monitoring in (i), (ii) [metals in mussel tissue, following section in this review] *and (iii) above shall be forwarded in writing to the Consent Authority within a month of sampling being undertaken. In addition, the consent holder shall notify the Consent Authority within 48 hours of becoming aware of any shellfish faecal coliform result that exceeds 300 MPN/100 g*.

It is important to note that the monitoring programme includes a control site at Victory Beach (Wickliffe Bay) that is not potentially influenced by the WWTP discharge. Although final discharge monitoring is undertaken for indicator bacteria, monitoring of shellfish at shoreline locations is undertaken to confirm that microbiological contamination has not occurred (due to shoreline wastewater excursions). This is discussed below.

4.1.2 Shellfish faecal coliform monitoring

Results of monitoring undertaken since 2012 (2012-2013. 2013-2014, 2014-2015 and 2015-2016 years are presented in Ryder (2013, 2014, 2015, 2016).

Ryder (2013 to 2016) reported exceedences of faecal coliform numbers in relation to the MoH (1995) “microbiological reference criteria for food”.

Table 6 provides a summary of the exceedances of the single sample exceedance identified in the consent.

A faecal coliform concentration of 230 MPN/100 gm represents an acceptable level and values above it are marginally acceptable or unacceptable in terms of the sampling plan. Values above 330 MPN/100 gm are unacceptable in terms of the sampling plan and detection of one or more samples exceeding this level would be cause for rejection of the lot (sampling plans should have a minimum of 5 sampling runs) (Ryder 2016).

Table 6: Number of quarters in each year that faecal coliforms in mussels exceeded 330 MPN/100 g.

Year	Lawyers Head	Smaills Beach	Boulder	Sandfly Bay	Sandfly Bay North	Victory Beach
2015-2016	**2**	**2**	**1**	**1**	**0**	**1**
2014-2015	**2**	**1**	**0**	**0**	**0**	**1**
2013-2014	**1**	**0**	**0**	**1**	**0**	**3**
2012-2013	**2**	**1**	**1**	**1**	**2**	**1**
2012-2016	**7/16**	**4/16**	**2/16**	**3/16**	**2/16**	**5/16**

Golder notes that although MoH (1995) criteria have been in use for a long time and was referenced by FSANZ (Food Standards Association of Australia and New Zealand) there have been changes in food standards within Australasia since the monitoring program commenced.

The MoH (1995) guidelines set out the statistical basis as to how foods are sampled for testing. Typically in comparing with the food guidance the sampling process involves replicates as the result is about being able to inform consumers about the quality of the food. So 'n' in the guidance refers to "the number of sampling units which must be examined from a lot of food to satisfy the requirements of a particular sampling plan". However, the consent condition for reporting elevated microbial contamination can be read as any exceedance above the limit specified.

The guidance (in both the 1995 document and the FSANZ discuss food sampling) can be applied to a single sample. However, the number of samples influences what one can use the comparison with the "microbiological criterion". The 1995 guidance identified that each sample should comprise a minimum of 12 shellfish of a suitable size. The limits were m (230 faecal coliforms/100 g) and M (330 faecal coliforms/100g).

Revised Food Standards Code (FSANZ 2016) came into effect on 1 March 2016. FSANZ (2016) uses *E. coli* as the indicator of food suitability for consumption. The corresponding figures to those noted above for m and M[1] are 230/100 g and 700/100 g. This is similar (for m) to the EU monitoring system that requires all shellfish (directly consumed) to contain less than 230 *E coli*/100 g.

Repeat sampling of shoreline mussels has shown that there appears to be a relatively high occurrence of elevated faecal coliform counts in shellfish samples at several of the monitored sites. These counts provide an indication that the shellfish are considered unsuitable for consumption. All Ryder reports prepared since 2013 report that other shoreline sources of indicator bacteria are present and identify stream, riverine and other biological sources (e.g., seals).

Microbiological quality of recreational food sources is important and a key aspect of the WWTP discharge monitoring program. As such, it is recommended that DCC undertake a bacterial source tracking study to provide useful information as to the bacterial sources contributing to the bacteria reported present in the shoreline mussels. Exploratory bacterial source studies have been undertaken by regulatory agencies internationally and in New Zealand. Auckland Council has undertaken source tracking to determine the sources contributing to elevated bacterial indicator numbers in coastal waters in Auckland. Source tracking has been used to identify the source of contamination in shellfish (e.g., Mauffret et al. 2013) and have included assessment of contributions from wild mammals (including seal) (Woodruff et al. 2009, Magill et al. 2013)

The key outcome from the shellfish monitoring undertaken by DCC is that elevated bacterial numbers are found in shoreline shellfish that require reporting to ORC. However available information indicates that multiple sources of bacteria may be responsible for the numbers reported (in particular catchment runoff).

[1] M and M are defined in Standard 1.6.1 as:

the number of sample units having a level of a microorganism greater than that listed in the corresponding row of Column 4 (***m***) is greater than the number listed in the corresponding row of Column 3 (***c***); or (ii) the level of the microorganism in any of the sample units is greater than the number (if any) listed in the corresponding row of Column 5 (***M***). Schedule 27 (microbiological limits in food) then confirms that for bivalve molluscs other than scallops, n = 5, c = 1, m = 230/100 g and M = 700/100g.

Elevated numbers of bacteria occur at the control site at a frequency similar to all other sites. Resampling is carried out when data is received that indicates the presence of elevated bacterial numbers in shellfish. The resampling typically shows a return to low bacterial numbers in the repeat sample (and that is also at the control) which may suggest widespread local sources (e.g., waterborne land based sources). Technically there is no reason why the control site is resampled.

The multiple years of sampling of shoreline shellfish have shown that bacterial contamination is present. However the source of the bacterial contamination is not identified. This is a significant monitoring program and as such the review has provided a recommendation in relation to source tracking with the aim of providing the appropriate data to support a review of this aspect of the program.

4.1.3 Shellfish enterovirus monitoring

The two rounds of enterovirus testing (October and April) over each of the last four years have revealed no detectable concentrations of these viruses in shellfish collected from any of the surveyed sites. This is the same result as found in the previous surveys, but differs from the 2010/2011 survey and the 2008/2009 survey when viruses were found in shellfish on one occasion in each of those years.

4.1.4 Shellfish compliance statement

Consent condition 6d requires that any faecal coliform numbers in mussels above 300 MPN/100 g be notified to the ORC. Exceedences of the limit have occurred a total of 23 times at six of the shoreline monitoring locations. These have been reported to ORC

No enterovirus have been detected in shoreline mussel samples collected since 2012.

4.1.5 Recommendations

It is recommended that investigations be carried out to assess the potential source of the bacteria present in shellfish (or coastal waters). Following collection of source tracking information from bacterial samples, the extent and nature of any shoreline monitoring program (both water and shellfish) should be reviewed.

It is recommended on the basis of results obtained to-date that the enterovirus in shellfish testing be removed from the program.

4.2 Shellfish Trace Element Monitoring

4.2.1 Monitoring requirements

Condition 6 (d)(ii) requires:

ii) Monitoring of metals in mussel flesh once between April and May each year. Sampling is to be undertaken in conjunction with the faecal coliform monitoring outlined in (i) above. Samples are to be collected from Blackhead, Second Beach, Lawyers Head Beach, Boulder Beach and Victory Beach. Metal testing of the mussels shall include aluminium, zinc, silver, nickel, lead, copper, chromium III and cadmium. A record of the number and size (length) of the shellfish analysed in each sample shall be provided.

4.2.2 Monitoring purpose

It is assumed monitoring of trace elements in shellfish was included in the consent to provide information on:

- Potential accumulation of trace elements by marine biota (represented by shellfish)
- Potential accumulation of trace elements by shellfish which are available for collection for consumption

Both monitoring objectives require slightly different sample management approaches as they require different consideration of the gut contents, particularly if the gut contains sediment. Aluminium was included in the list of analytes. Based upon the Ryder (2016 and prior reports), the aluminium appears to have been included to assess its uptake. It is more than likely it was included as a measure of the sediment content in

the shellfish which were not depurated (the processing of naturally or forced flushing of gut contents) (refer Kennedy 1986).

The consent specifies the analysis of chromium (III). However, total chromium has been measured. Golder is unaware of a reason to specifically measure the trivalent form directly in shellfish, as consumption and uptake is typically assessed as total chromium.

4.2.3 Field and Lab methodology

Ryder (2013 etc.) provide a general indication of the number (12 to 15) and size of the mussels (80 mm to 160 mm) collected. For shellfish testing it is useful to record the actual number included in the composite sample and the lengths of all individuals. This allows average wet weight information to also be obtained. Examination of the laboratory reports indicates that the number of shellfish included in the analysis is identified and the total weight of those shellfish is identified, which could be used to provide information on the average individual wet weight. If average individual size data is unavailable, the average wet weight is a useful measure of the size similarity between years.

Sample collection is required between April and May each year. Up to 2013 samples were collected in April and October each year. Subsequently all sampling for trace elements occurred in April as required by the resource consent. Spreadsheets containing trace elements data did not identify whether the data presented was as dry or wet weight. Following receipt of laboratory reports, the reports provide all data on a wet weight basis and provide the wet/dry weight ratio.

4.2.4 Monitoring results

Shellfish concentration data in Ryder reports for the years 2013 to 2015 are presented in mg/kg (dry weight). The tables summarising the commonly identified limits for consumption of foodstuffs is also identified as mg/kg (dry weight). However, all food standard related information published by regulatory agencies is presented in “as received” (wet weight) concentrations to allow direct calculation of dietary intakes. This has resulted in an overly conservative comparison of shellfish concentration data collected over the last three rounds of monitoring with food standards.

Following receipt of the shellfish laboratory data, the trace element analytical data was reviewed. As noted above, it is assumed that the key purpose of assessing the trace element concentrations in the mussel samples is to identify if the concentrations are elevated compared to what would be expected in this species.

The key observations from the data review are:

- Cadmium and nickel concentration data showed little variation between years and in response to changing aluminium concentration (Figure 4). Nickel data fell within a relatively narrow band of concentration over all surveys shown in Figure 5.
- Zinc concentrations varied little between years but appeared to have a slight linear relationship with aluminium. The April 2011 sampling round results stood out as different to all other data. Given the uniformity of all other years (Figure 5), the results for that survey appear to be anomalous.
- Chromium and lead concentrations appear to correlate with aluminium concentrations in the shellfish samples across all sample years. This suggests that much of the chromium and lead in the samples may be derived from any sediment present within the shellfish.
- Copper concentrations appear to show little relationship to aluminium and most data fall within a relatively narrow band over time.

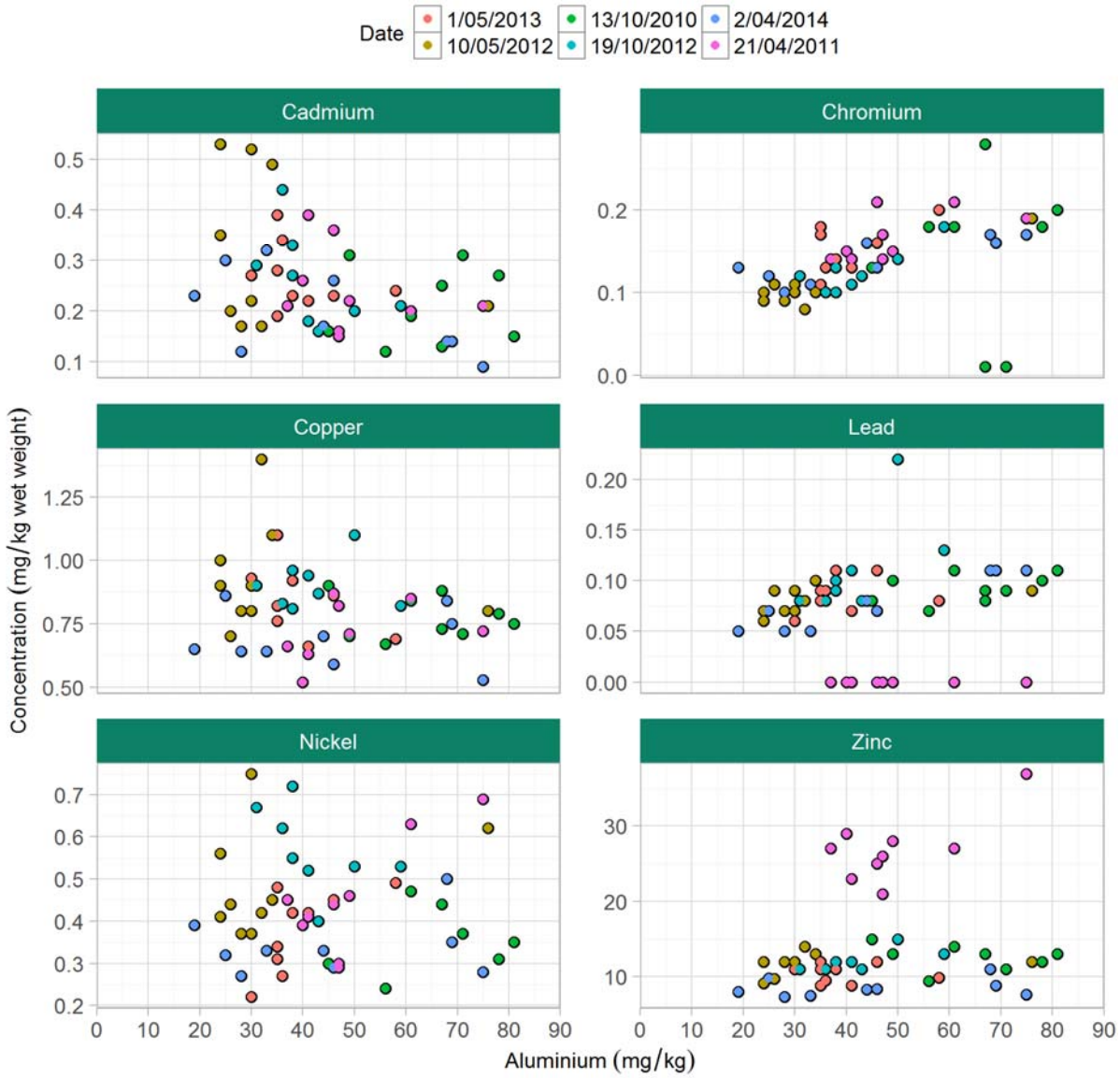

Figure 4: Trace elements in mussels.

If sediment or other material is having any influence on shellfish concentrations the "effect" is a function of the basic shellfish concentration and the concentration of element in the material (in the gut etc.,) adding to what is present in the tissue. The points arising are:

- Chromium and lead concentrations may be related mainly to how much non-shellfish material (e.g. sediment) is present in the sample
- Cadmium, nickel and copper concentrations appear unchanged over time and by extraneous material in the gut
- Zinc concentrations appear to vary little over time and may be influenced slightly by gut contents

A further point that needs to be considered is that of the elements included in the monitoring program, not all are biologically important. In relation to all biota, it is generally considered that:

- Copper, lead and zinc data for green lipped mussel indicates that gut content related variation may be minor but size related differences are likely to drive variation in sample concentrations.
- Copper may be involved in a variety of physiological processes.
- Cadmium concentrations may be higher in small green lipped mussels. High cadmium concentrations have been reported in mussels elsewhere in the world.
- Lead concentration differences have been noted historically in New Zealand due to the distribution of lead from combustion of petrol.
- Nickel has been reported at higher concentration in smaller mussels in other international studies.
- Zinc relationships are unclear. Zinc concentrations in tissues may be regulated up to a threshold. Some higher concentrations have been reported in smaller mussels.

4.2.5 Food safety

We have included this section in the review as one of the purposes of undertaking shellfish contaminant measurements is to ensure that trace elements do not limit the collection of shellfish for human consumption. This is assessed by comparing the concentrations measured with food standards (as has occurred in the annual shellfish reports, Ryder (2013) through Ryder (2016). Standards are typically produced to ensure that long term consumption of foodstuffs will not have adverse health effects. These are based on assumptions about seafood consumption. The New Zealand (Australia New Zealand Food Standards Code) Food Standards 2002 stipulate the following guidelines for concentrations of trace metals in shellfish tissue:

- Cadmium: 2 mg/kg (wet weight)
- Lead: 2 mg/kg (wet weight)
- Mercury: 0.5 mg/kg (wet weight) – as an average of five samples

We note that the shellfish monitoring program has not included the analysis for mercury.

There are no published guidelines for acceptable concentrations of chromium, copper, nickel or zinc in shellfish tissue, although the previous food standards (New Zealand Food Regulations 1984, revoked in December 2002) prescribed a copper guideline of 30 mg/kg (wet weight) in any food except animal offal and tea. As noted in Ryder (2016), the New Zealand Food & Drug Regulations (1984) contained limits for lead and cadmium which have been superseded by the FSANZ guidance. The earlier guidance also provided guidance for copper and zinc in shellfish. These limits as noted by Ryder (2016) as 150 mg/kg and 2,000 mg/kg (dry weight) rather than in terms of wet weight.). Table 7 provides a summary of food standards for trace elements.

Ryder (2012) notes “with only cadmium at Sandfly Bay south and north (October 2012) and Boulder Beach and Allens beach (April 2013) exceeding the Australia/New Zealand Food Standards (Figure 5)”. As noted above the cadmium data presented in Ryder (2012) and other reports were presented as dry weight concentrations. Figure 6 displays the cadmium data for mussels collected from the nine sites for the four sampling episodes between May 2012 and April 2014 (based on available laboratory reports). The data clearly indicates that the cadmium concentrations are below the Food Standard limit of 2.0 mg/kg (wet wt). However, the data suggests that there are geographical differences between sites in the concentrations measured and these tend to be consistent between years. That is, the concentrations at Boulder Beach, Sandfly South and North Beaches and Allans Beach have higher cadmium concentrations than other beaches. The possible reason for this consistent difference is beyond this review but may be related in part to local salinity effects (as cadmium may be more available with lowered salinity).

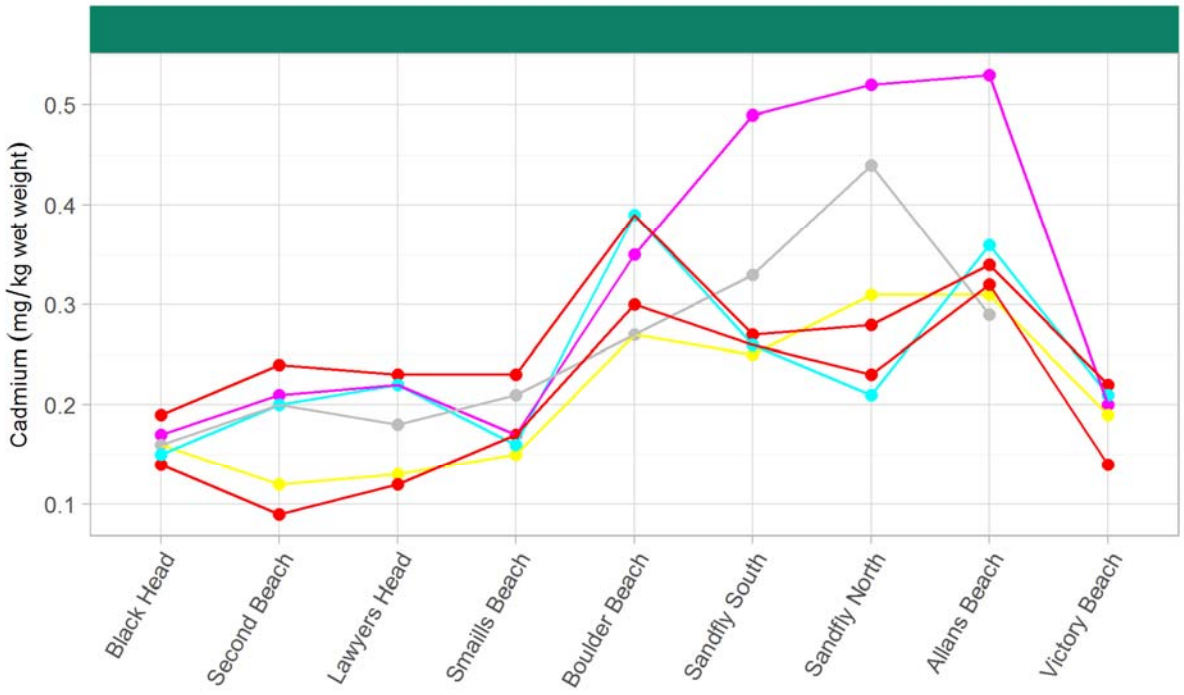

Figure 5: Cadmium concentration in mussels at beach monitoring sites.

In relation to FDA guidance, Golder has not been able to corroborate all of the numeric consumption limit values identified by Ryder. Except for nickel, the numbers Ryder cites differ from those that could be located in various FDA documents. The current numeric values that should be used are those of FSANZ for cadmium and lead, and those of the FDA (2009) for chromium and nickel. The key aspect of the food quality limits that must be considered is the consumption assumptions and the risk factors.

Table 7: Food quality limits for trace elements.

Source		Shellfish	Cd	Cr	Pb	Ni
Ryder (Food Regs/NZDoH)	Dry wt	Not defined	5	-	10	-
FSAI (2009)	Wet wt	Shellfish (bivalve molluscs)	1.0	-	1.5	-
EU (2006)	Wet wt	Shellfish (bivalve molluscs)	1.0		1.5	
FSANZ (2016)	Wet wt		2[A]		2[A]	
MHPRC (2013)	Wet wt	Bivalves	2	2.0[B]	1.5	1
FAO	Wet wt	Bivalves	2[C]		0.3[D]	
FDA (2009)	Wet wt	Shellfish	4	13	1.7	80
FDA (1993)	Wet wt	Clams, oysters, and mussels [E]	4	13	1.7	80

Notes: [A] cadmium: molluscs (except dredge/bluff oysters), lead: molluscs; [B] limit for "aquatic animals and their products"; [C] Excluding oysters and scallops; [D] No limit for shellfish – limit for fish provided; [E] Assuming a 90 %ile 14-day average intake of molluscan bivalves of 15 g/person/day, for 2+ years (all ages) eaters only.

No shellfish trace element concentrations in any samples exceed guideline values. Cadmium at a number of beach sampling sites come within 40 % of the FSANZ guidance concentration. Cadmium food standard

concentrations assume that the cadmium is present as inorganic cadmium. In the case of mussels this is unlikely. It is likely that some of the cadmium is likely to be present in the metallothionen complex (as occurs with species of oysters (e.g., Bluff oysters)). This reduces the uptake of cadmium with the cadmium being excreted following consumption.

4.2.6 Shellfish compliance statement

Shellfish quality sampling for trace elements undertaken has been compliant with the requirements of the resource consent.

Concentrations of a range of trace elements have been measured for over a decade in green lipped mussels. Of the elements measured, only cadmium, chromium, lead and nickel can be compared to current food safety guidelines. Aluminium has been included in the testing program but the rationale for its inclusion is unclear. Reporting to date appears to assume that it is included as a contaminant.

Trace element concentrations in mussels have incorrectly been compared with guidelines on a dry weight basis rather than on a wet weight basis.

4.2.7 Recommendations

It is unlikely that ongoing shoreline green-lipped mussel sampling will identify changes in trace element concentrations derived from the WWTP discharge. As such consideration should be given to changing the frequency of the sampling programme (e.g., five yearly) or removing the shellfish assessment from the monitoring programme. The review recommendation is to remove this element of the monitoring programme.

5.0 ECOLOGY

5.1 Rocky Shore Ecological Monitoring

5.1.1 Monitoring requirements

Condition 6 (c) requires that:

The consent holder shall undertake biological rocky shore monitoring annually, at Blackhead, Second Beach, Lawyers Head Beach, Boulder Beach, Allans Beach and Victory Beach. Monitoring methods shall be consistent with the methods employed under Coastal Permit 97530.

5.1.2 Survey purpose

It is assumed that the intended purpose of the consent condition and rocky shore surveys is to assess whether the discharge is having any observable effects on the rocky shore communities at locations up-current and down-current of the outfall.

5.1.3 Field and lab methodology

As per the consent condition the methodology for the rocky shore surveys is said to be outlined within Coastal Permit 97530. However, at the time of writing, this methodology within the Coastal Permit was unable to be viewed. Consequently it is unable to be verified if the methodology employed for the rocky shore surveys is consistent with this Costal Permit.

The methodology that has been employed for the surveys, since 1997, is said to be based on other regional monitoring programmes operating in the Bay of Plenty, Southland and Taranaki (Ryder 2016). The methodology investigates species richness and diversity, both within sites, and between sites. The use of replicates increases the potential collection of rare taxa and allows the determination of any significant variations that may exist.

Six survey sites were selected – three 'impact' sites (Second Beach, Lawyers Head and Boulder Beach) that were located relatively close to the discharge, and three 'control' sites (Black Head, Allans Beach and Victory Beach). These sites all contain significant areas of rocky intertidal habitat. There is variations in this intertidal rocky substrate with some sites having more smooth rocky boulders, while other sites have rough basalt rock with many niches and ledges. These differences in substrate will influence the nature of the algae and animal communities present.

Field methods used random block sampling, with four blocks randomly positioned at low tide at each site. Macroalgae and macroinvertebrates were identified and recorded from within five randomly placed quadrats (0.25 m^2), within each of the four blocks, giving a total of 20 samples at each site.

Macroalgae species were recorded as a percentage cover, with some totals exceeding 100 % due to the nature of macroalgae to grow in layers. Macroinvertebrate diversity and abundance was recorded for all visible animals within each quadrat, with the majority recorded as counts. Some animals, including some barnacle, mussel, polychaete and tunicate species have been recorded as percentage cover. The number of animal species that were recorded as counts of individuals was increased in 2003, with an increase in taxonomic detail and improved identification methods. Not all species were identified to species level, with some fauna and flora that is hard to differentiate from similar species grouped by genus.

Sampling has been undertaken yearly between December and February, as per the consent. Sites Black Head, Second Beach and Boulder Beach have been sampled since 1996, providing substantial data sets.

The size and distribution of edible mussels (green lipped mussels, ribbed mussels and blue mussels) have also been recorded from within each of the 20 quadrats. As there is no information as to whether the site mussels have been recreationally harvested (for human consumption), the value of the size data is questionable.

5.1.4 Data management

The results from pre-2001 surveys were presented descriptively, on a species by species basis, with limited statistical analysis undertaken. Multivariate statistics has been employed on surveys undertaken after 2001, allowing the entire group to be analysed, rather than on a species by species basis. The following observations were made in relation to data in provided spreadsheets/reports:

- Frequency of mussels present within each size class is calculated by dividing the total number observed across all four blocks, by five.
- Within Ryder (2016) the results of the ordination are only presented for each replicate, at each site. No averages per block, or per site are presented. Historical data is also not presented for interpretation via an ordination plot.

5.1.5 Monitoring results

Taxonomic richness and diversity show variability across the sampling years, but is generally similar, with no clear trends that are able to be attributed to the outfall. Rocky shore sites show great within-site variability, with some replicate samples having a community more similar to those from other sites, than to replicates within the same site. This variability has been evident across the sampling years, with no clear patterns of community structure with proximity to the wastewater outfall.

The last survey, undertaken in January 2016, showed a diverse and healthy ecological community that did not differ significantly from communities observed in previous surveys. There is considerable overlap of community structure between sites, with no clear patterns with proximity to the outfall evident for either algae or animal communities.

The number of species present across the survey sites continues to be higher for surveys after 2004, owing to the increased level of taxonomic identification for both algae and animals, and the increased effort of counting animal species.

The analysis of abundance and size frequency of the three predominant mussel species shows no trends of distribution, with through time, or with proximity to the outfall.

Sand build up in 2013 was present again 2016. This build-up of sand had covered a significant amount of the intertidal area. It is assumed that this sand had smothered areas of what was previously rocky intertidal habitat. Depending on low-tide access to the lower-intertidal zone, taxonomic richness should be viewed 'cautiously' as some of the differences observed were said to be 'likely due to different intertidal levels being available at different surveys due to varying tide heights'.

5.1.6 Rocky shore compliance statement

Rocky shore monitoring at areas surrounding the Tahuna WWTP outfall has been undertaken for up to twenty years, across a number of sites. No significant differences in rocky shore algae or animal communities has been observed in relation to the outfall across this time. Natural variability in these rocky shore communities is high owing to the high energy and dynamic habitat. Because of this natural variability any small potential effects on these communities are not likely to be observed or determinable. It is unlikely the Tahuna Outfall is having any adverse effects on the rocky shore community at sites adjacent to the outfall.

5.1.7 Recommendations

The following recommendations are made:

- Frequency of rocky shore monitoring be reduced to once every five years.
- If significant differences in communities are observed, then a repeat survey is to be undertaken the following year.
- Standardisation of the location of 'low tide' within each site. This will ensure that any differences observed are as a result of differences in communities, not a change in location up or down the intertidal.

5.2 Benthic Ecological Monitoring

5.2.1 Monitoring requirements

Condition 6 (f) requires that:

The consent holder shall undertake annually, between December and February a sub-tidal sediments and benthic survey. The survey shall assess contaminants in the sediments as well as the number and types of species living in the sediments. Samples shall be collected at 10, 50, 250, 500, 100 and 2000 meters each side of the 1100 m offshore outfall and generally parallel to shore, as well as from Victory Beach, which is to be the control site. A minimum of three replicate samples shall be collected for each site and analysed for total aluminium, zinc, silver, nickel, lead, copper, chromium and cadmium.

The results of this monitoring shall be reported in writing to the Consent Authority by 30 April each year.

5.2.2 Survey purpose

The objective of the subtidal benthic survey is to:

- Assess the current environmental in the terms of the presence of unique or outstanding features
- To provide data against which past and future studies can be compare to assess any changes that may result from the wastewater discharge.

5.2.3 Field and lab methodology

The marine environment surrounding the outfall is predominantly comprised of sand and broken shell, with the occasional rocky reef.

Samples were collected from each of six sites either side of the outfall at specific distances, and running parallel to the shoreline at approximately 1,100 m offshore, and a single 'control' site at Victory Beach.

Methods employed in the 2016 survey (Stewart 2016) were the same as previous surveys in 2004, 2006 and 2010-2015 inclusive. At each site three replicate benthic cores of 85 x 250 mm were collected, and sieved through a 500 µm sieve. Samples were then preserved in 70 % ethanol.

Taxonomic identification of macroinvertebrates was completed to the family level, with different species of the same family not identified separately, but rather grouped under the family.

5.2.4 Data management

The following observations were made in relation to data presentation in provided spreadsheets/reports:

- Number of animals has been scaled up and presented as number of animals per square metre. Given the naturally patchy distribution of a number of the taxa present, scaling up abundance can be very misleading, as some may never naturally occur in densities estimated through scaling up. Distributional density has to be considered when scaling up species data to build pictures of communities. Core sizes are used that are generally representative of most of the common species. However, it should be noted that larger species that might have densities that low compared to core size or smaller species that are patchy are not ideal for data scaling.
- Some taxa are identified to the family level, others to the species level. It is unclear if and which taxa may actually be representative of a number of different species grouped within their family.
- Within the report the number of taxa within the Polychaetes are referred to as ‘species’. The methodology states that the lowest taxonomic resolution of invertebrate identification was to the family level.

5.2.5 Monitoring results

The benthic invertebrate communities that were present were of relatively low abundance and relatively species poor; results that are consistent with previous surveys. The ‘Visually dominant’ taxa across the recent surveys were crustaceans and polychaetes. This is an arbitrary measurement as it is based on visual observations, not actual counts. Alongside polychaete and crustaceans families, foraminiferans were numerically dominant when samples were viewed under a microscope.

Benthic community diversity and abundance were tested for any significant differences both with distance from the outfall, and direction from the outfall. No significant differences were observed that were attributable to the discharge.

No rare or exceptional taxa were said to be identified at any of the sites in 2013-2016 inclusive, however it is not explained how a species is determined to be ‘rare or exceptional’. In 2013-2016 inclusive a number of taxa that are considered to be sensitive to pollution were observed.

The macroinvertebrates present were typical of physically disturbed environment, with many species present that have patchy distributions. The subtidal benthic habitat surrounding the Tahuna Outfall is naturally dynamic with physical disturbance from high energy waves and sediment instability. Consequently the benthic communities have a naturally high variability. This variability was evident both within sites, and between sites, in pre-outfall surveys and is still evident in all surveys undertaken since the commissioning of the outfall.

5.2.6 Benthic ecology compliance statement and recommendations

The results from the post-commissioning surveys and comparisons with pre- commissioning surveys indicate that there are no significant impacts to subtidal benthic communities that are attributable to the outfall.

Owing to this, the following actions are recommended:

- Reduction of the sample effort through the ‘holding’ of samples, with the intention that they be processed if results of remaining sites indicate a potential effect.
    - Collect replicate samples from each site, as has been undertaken previously. Preserve all samples.

  - Process and analyse benthic communities from Sites 10, 50, 250 and 2000, both east and west of the outfall.
  - Hold the remaining samples for processing at a later date, should this be required.
- It can be difficult to establish if foraminiferans were dead or alive at the time of sampling. Inclusion of the methods used to differentiate between dead and alive specimens should be included.
- The use of stain, such as rose Bengal, is recommended to increase the visibility of small invertebrates within the samples to increase sorting accuracy (if not being used).
- Following two years of sampling, results should be reviewed and sampling then carried out in three years and then on a five year sampling period.

5.3 Sediment Quality Monitoring

5.3.1 Monitoring requirements

As noted above, Condition 6 (f) requires that sediment samples are collected at the same time that the annual benthic ecological survey is being undertaken. The methodology states that three replicate samples be collected at each site. As noted in the ORC audit reports, only one sample has been collected at each site since 2006. ORC (2016) notes that:

*The 2005 (pre-outfall) sampling found extremely low sample variance, and due to time constraints for divers, verbal agreement was reached that one sample would be sufficient in the future. This arrangement was reassessed in 2014. It was agreed that metal results have been sufficiently low as to not warrant concern; however it is important to be able to identify any increasing trends in metal concentrations before the guidelines are exceeded. Should results suggest an adverse trend that requires further investigation, additional replicates in future surveys may be require*d.

The comments provided in this section are based upon Ryder (2013, 2014, 2015) and spreadsheets of data for the 2014, 2015 and 2016 years. Data were extracted from Ryder (2013) to compare to data from subsequent years.

5.3.2 Survey purpose

It is assumed the purpose of the survey was to assess whether the discharge of contaminants in the outfall discharge was influencing the concentration of trace elements in sediments adjacent to the outfall.

5.3.3 Field and laboratory methodology

Sampling has been undertaken in all surveys by collecting samples from the top 5 cm to 10 cm of sediment. Depth of sampling should be related to the nature of the sediment and the amount of disturbance and bioturbation. Deeper sediment samples typically reduce the ability to detect change as the addition of contaminant can be diluted by the bulk of the sample. In sandy samples any contaminant associated with discharge particulates, adsorbing to suspended particles, or flocculating that settle to the seabed, will typically be fine. The ability to detect any addition will depend on the flux and the amount of fine material in the sediment. Detecting sediment associated contaminants in sandy seabed typically requires that the fine sediment be examined (typically the <0.063 mm particles). This also makes direct comparison between sites easier.

The methodology does not state what sediment fraction was used for the analysis. This could be either whole sediment or <2 mm material.

It was noted when reading the reports that a single sample was collected at each site. Although Golder understands the rational why sediment sampling and analysis was reduced to a single sample, it will be more difficult to detect any trend should it be apparent based upon a single sample being compared between years. Replicate samples would assist in this process. There are alternatives to reducing sampling and analytical effort. For example, on could:

- Collect all samples but only undertake analysis one from each location.
- Obtain replicate samples at 10 m, 50 m and 250 m either side of the outfall, with single samples at 500 m, 1,000 m and 2,000 m.

5.3.4 Data management

The following observations were made in relation to data presentation in provided spreadsheets/reports:

- All silver data and all but two cadmium results in the 2016 spreadsheet were reported as BDL rather than reporting the detection limit.
- The 2015 data spreadsheet and Ryder (2015) reported cadmium and silver concentrations for five samples as 1E-05 or 0.00001 mg/kg. This is discussed further below.
- The 2014 data spreadsheet and Ryder (2014) reported unusual results for a sample collected at monitoring site 1000E. Six of the parameters analysed have a result that is at odds with the results obtained for all other samples. No comment was provided about the unusual result or the sample re-tested.
- The data for 2013 in Ryder (2013) differs to more recent years in that with the exception of aluminium, lead and zinc, the other elements were either not determined or reported with sufficient precision or to an appropriate decimal that it cannot be compared to more recent data.
- The evaluation of the laboratory sediment trace element concentration data presented in the Ryder annual reports, has identified that the laboratory in the opinion of this review has inappropriately reported concentration data without correctly identifying the laboratory method limit of detection for each element. In our view this has little implication for those elements present in sediment at readily measurable concentrations (e.g., chromium, copper, nickel, lead and zinc). However, for cadmium and silver, the data have been inappropriately transferred from the laboratory reports to the trace element in the report sediment summary tables. In just about all cases the concentration of both elements should be reported as less than the method detection limit.

5.3.5 Monitoring results

Monitoring results for trace elements have been compared to the ANZECC (2000) ISQG-Low sediment quality guidance values.

Ryder (2013, 2014, 2015) makes reference to there being no specific ANZECC (2000) guidance value applicable to aluminium. Aluminium is reported and discussed in each report as if it is a “contaminant”. There will be some ‘contaminant’ aluminium within the discharge as it is a common element and will pass through the WWTP. However aluminium is the most abundant crustal metallic element and hence a dominant sedimentary structural element.

Golder suspects its inclusion in the monitoring parameter list was not as a contaminant but as a surrogate element for the geochemical nature of the sediment (i.e., a proxy for the particle size characteristics of the sediment. In many sedimentary systems where there are abundant alumino-silcates, there are typically close natural relationships between aluminium concentrations and many of the trace elements. Examination of the ratios of aluminium to most of the trace elements (copper. chromium, nickel, lead and zinc) show close relationships with most of the data within a small “cluster”. Some-inter-year differences are evident (e.g., in the aluminium/zinc slope which probably indicate inter-year laboratory analytical differences), but when each year is examined few samples stand out as unusual. One example is the elevated nickel concentration at 10E in 2015. Plotting lead and zinc pairs (as shown in Figure 6) shows that there is little variation in either elements.

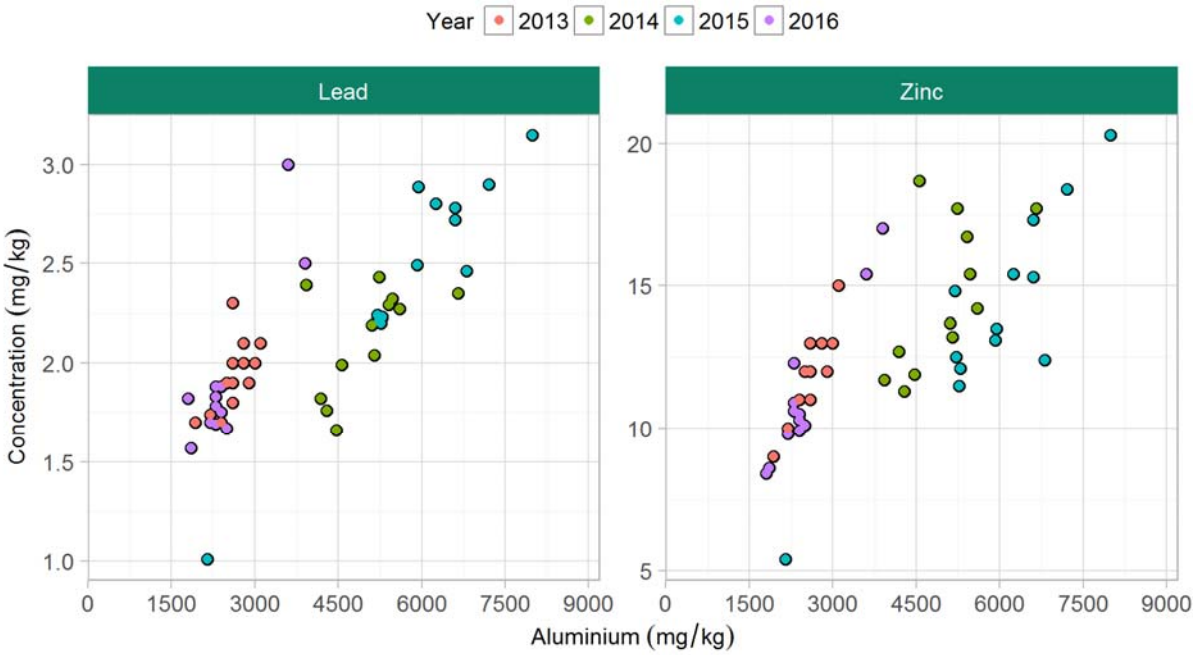

Figure 6: Relationship between aluminium and each of lead and zinc in sediments.

5.3.6 Sediment quality compliance statement

Benthic sediment sampling has been carried as required by the resource consent and subsequent variations to the sampling method as agreed with ORC. Sampling has been undertaken every year as required by the consent.

Coastal sediments around the outfall are sandy in nature with some areas close to the discharge point that are shelly. As such, analysis is undertaken on whole sediment which is dominated by sand. The use of whole sediment limits the ability of the monitoring to detect any changes in sediment quality in the vicinity of the discharge as any contaminants present as a result of the discharge will be associated with fine particle sizes. Examination of the data has shown that there is no evidence of any anomalous data that would suggest obvious contamination from the discharge. The data suggest that small variations in inter-year concentrations may obscure the detection of small changes in sediment concentration that might be due to outfall contributions.

Trends and differences over time at any location will only able to be detected using replicated sampling. In its absence the value of the survey is significantly reduced.

5.3.7 Recommendations

It is recommended that the sampling programme is amended as follows:

- Collect sufficient sediment to allow the <0.063 mm sediment fraction to be separated from the whole sample and analyse this sediment fraction.
- Aluminium should continue to be included in the analysis as a reference element.
- Replication should be brought back into the programme to allow inter-site differences to be assessed.
- The programme should be carried out with the corresponding benthic ecology monitoring sampling round, then the results reviewed and if no significant differences in the concentrations of key elements in the fine sediment fraction are detected, then the frequency should be reduced in line with the benthic

ecological monitoring (i.e., following two years of sampling, results should be reviewed and sampling then carried out in three years and then on a five year sampling period).

6.0 AIR QUALITY

6.1 Musselburgh Biofilters and Diesel Generators

6.1.1 Condition

Condition 5 (Consent No. 2006.825) states:

The consent holder shall adopt the best practicable option to avoid or mitigate any potential adverse effects on the environment arising from discharges from the consent holder's activities. This shall include, but not be limited to the following:

a) ensuring all significant odour sources are enclosed and ventilated to odour control equipment at all times and that odour control equipment is maintained in good working order;
b) biofilter media pH shall be measured and recorded once every 3 months from the commencement of this consent and be maintained at pH 6 or greater;
c) biofilter media moisture content shall be measured and recorded using gravimetric analysis once every month, from the commencement of this consent;
d) biofilter media temperature shall be measured and recorded once every month, from the commencement of this consent;
e) overall biofilter bed and distribution pipe-work pressure shall be measured and recorded weekly, from the commencement of this consent;
f) the total air extraction rate (cubic metres per second) to the biofilter beds shall be measured and recorded once every month, from the commencement of this consent;
g) once every year from the commencement of this consent, the consent holder shall undertake maintenance and timing inspections of the diesel generators.

The consent holder shall forward a record of the results of all monitoring and inspections undertaken in accordance with this condition, and any interpretation of the results, to the Consent Authority annually, from the commencement of this consent, or on request.

6.1.2 Frequency

Pressure measurements (weekly)

The frequency of pressure measurements of the Musselburgh Biofilters is generally compliant with consent requirements from 2014 onwards, but with some inconsistencies that could be improved.

Until the end of 2013, there were approximately 14 occasions when the measurements of the overall biofilter bed and distribution pipework pressure were not carried out weekly. On those occasions, intervals between measurements varied from 14 to 35 days and were 18 days on average. From 2014 onwards, the pressure measurements have been carried out approximately weekly and generally comply with the consent requirement. However there were six occasions in 2014 when the intervals were between 14 to 15 days, and one occasion in 2015 when there was a 27 day interval between pressure measurements. It is not clear if these intervals were due to plant shutdown or maintenance, or any other reason for not following the weekly measurement requirement.

Moisture, temperature and air extraction rate measurements (monthly)

The frequency of these measurements is compliant with consent requirements for temperature and air extraction rate measurements, and generally compliant for moisture measurements from the second half of 2014 onwards.

There were no moisture measurements for the eight months period between November 2013 to June 2014, and for the month of October 2015. It is noted that the temperature and air extraction rate measurements have been generally carried out on a weekly basis rather than monthly, demonstrating good practice.

pH measurements (quarterly)

The frequency of pH measurements of the Musselburgh Biofilters is compliant with consent requirements.

The pH measurements have been generally carried out on a monthly basis rather than quarterly, which demonstrates good practice and provides useful information for managing the performance of the biofilters.

Diesel generators maintenance and timing inspections (annually)

The frequency of these inspections is compliant with consent requirements.

Preventive maintenance check sheets of the generators have been filled out monthly from January 2013 to June 2016, which includes an inspection of the various systems (lubrication, cooling, fuel, exhaust, etc.) that constitute the generators.

6.1.3 Method

The only method required by condition 5 of Consent No. 2006.825 is the gravimetric analysis for measurement of the biofilter media moisture. The method used for this measurement was not evaluated for compliance with consent requirements. It is suggested that the methods used for measuring all the biofilter parameters are included in the monitoring records.

6.1.4 Limits and performance

pH measurements

The pH measurements of the Musselburgh Biofilters are non-compliant with consent limits. However, the biofilters performance is evaluated as effective based on recorded pH levels.

Condition 5(b) of Consent No. 2006.825 requires the pH of the biofilters beds to be maintained at 6 or greater. Although over 50 % of measurements since June 2012 have been below a pH of 6, nearly 93 % of all measurements have been above a pH of at least 5. Additionally, the average pH since 2014 has been of 5.7. Golder considers that a pH of 5 or higher in the top 2/3 layer of the biofilter beds and a pH 3 or higher in the bottom 1/3 layers provide for an effective biofilter bed operation. This is reflected in the recommendations by Golder (2016)[2] and also in the Air & Odour Discharge Management Plan (ADMP) of the Operations Manual for the Tahuna WWTP biofilters beds. Golder considers this recommendation is also applicable to the Musselburgh biofilters.

Pressure, moisture, temperature and air extraction rate measurements

There are no consent limits for pressure, moisture, temperature and air extraction rate measurements. The performance of the biofilters based on the values recorded for these parameters is evaluated as effective.

Although condition 5 of Consent No. 2006.825 does not set limits for these parameters, recommended values for pressure and moisture are set out in the Tahuna WWTP ADMP and which Golder considers applicable to the Musselburgh biofilters as well. Additionally, a specific air loading rate limit for the Musselburgh biofilters is recommended by Kingett Mitchell (2006)3. The combination of these recommended values and evaluation of the measurements against them are detailed as follows:

- Pressure: this is recommended to be below 200 mm of water column (for the discharge pressure measured at the fans). The monitoring results spreadsheets provided by DCC indicate the pressure measurements to be in kilopascals (kPa). Based on the measured values, on discussions with DCC about the monitoring method and on information from Kingett Mitchell (2006), Golder however considers it is very likely that the pressure measurements are actually in mm of water column. Assuming this is the case, all pressure measurements made at fans 1 and 2 of the Musselburgh biofilters have been below the recommended limit.

[2] Golder 2016. DCC Tahuna WWTP – Review of Biofilters. Letter from Roger Cudmore to Chris Henderson dated 9 March 2016. Golder Associated (NZ) Limited.

[3] Kingett Mitchell 2006. Assessment of Air Discharges – Musselburgh Pump Station, Dunedin. Prepared by Kingett Mitchell Limited on behalf of Dunedin City Council. November 2006.

- Moisture: preferably in the range of 50 wt. % to 65 wt. %. Nearly 60 % of all measurements to date have been within this range and are on average 61 wt. %. The minimum and maximum moisture measurements are 34 wt. % and 77 wt. %, respectively.
- Temperature: usually periodic temperature measurements are recommended for the inlet air, as is the case with the ADMP for the Tahuna WWTP biofilters, and not for biofilter media as currently required by the consent of the Musselburgh biofilters. However, as discussed by Kingett Mitchell (2006), given the ambient nature of the air stream being treated by the Musselburgh biofilters, then temperature monitoring of the inlet air stream is not considered necessary in this instance. In any case, the temperature measurements of biofilter media have all been below 21°C and are 14°C on average. This is relatively low and well within recommended inlet air temperature of 35°C. Golder considers these measurements are not necessary and are not providing any useful information for the Musselburgh biofilters.
- Air extraction rate: the upper limit air loading rate recommended for these particular biofilters is 60 m^3_{air}/h per m^3_{media} (Kingett Mitchell 2006). Each bed is 12 m long by 12 m wide, and has a depth of approximately 600 mm of media, equating to a total volume of approximately 173 m^3 for the two beds. This translates into a recommended total upper air extraction rate of approximately 2.9 m^3/s. From June 2012 to August 2013, the measurements were above this upper limit, being 6.7 m^3/s on average. This performance significantly improved from September 2013 onwards, with over 99 % of measurements of total air extraction rate being below the recommended upper limit and being 2.0 m^3/s on average.

6.2 Biosolids Incinerator

6.2.1 Conditions

Condition 3 (Consent RM12.139.01.V1) states:

The concentration of contaminants in the air discharge from the biosolids incinerator, prior to discharge to the biofilters, shall not exceed the following:

Contaminant	***Limit***
Suspended particulate matter less than 10 micrograms in size (PM10)	*16 milligrams per cubic metre*
Sulphur Dioxide	*50 milligrams per cubic metre*
Oxides of Nitrogen	*200 milligrams per cubic metre as N02*
Hydrogen Chloride	*10 milligrams per cubic metre*
Hydrogen Fluoride	*2 milligrams per cubic metre*
Mercury	*0.1 milligrams per cubic metre*
Total Cadmium and Thallium	*0.1 milligrams per cubic metre*
Total Antimony	*0.5 milligrams per cubic metre*
Arsenic	
Lead	
Chromium	
Cobalt	
Copper	
Manganese	
Nickel and	

Contaminant	*Limit*
Vanadium	
Dioxins and Furans (PCDD/Fs)	*0.1 nanograms (toxic equivalents) per cubic metre*

All concentrations are corrected to 0℃, 101.3 kPA, dry gas and 11% oxygen.

Condition 4 states:

The consent holder shall measure the discharges from the biosolids incinerator to demonstrate compliance with the limits for each contaminant listed in Condition 3. The monitoring shall be undertaken in accordance with the following:

- *a) Samples shall be collected downstream of the scrubber system and prior to the discharge entering the biofilter.*
- *b) The test shall be undertaken annually, in October or November;*
- *c) Each test shall comprise three measurements and shall be undertaken as far as practicable when the incinerator is working at least 75% of the maximum biosolids combustion rate. Compliance shall be measured against the arithmetic mean of the three results;*
- *d) The consent holder shall record the plant's biosolids combustion rate, expressed as a percentage of maximum rate, during the tests;*
- *e) Results shall be measured as hourly averages with the exception of dioxins and furans, which shall be measured as three-hour averages.*
- *f) The toxic equivalents for dioxins and furans (TEQ) shall be determined from World Health Organisation (1997) toxic equivalency factors and one half of the limit of detection shall be included in the TEQ calculations for those congeners below the detection limit.*
- *g) When monitoring for suspended particulate matter less than 10 micrograms in size (PM10), the following shall apply:*
  - *i. The applicant shall follow method ISO 9096:2003, USEPA Method 17, USEPA Method 201A, or an equivalent method as agreed in writing with Consent Authority.*
  - *ii. Where total suspended particulate is measured under Condition 4g)i), it shall be assumed that all of the total suspended particulate measured is less than 10 micrograms in size (PM10).*
  - *iii. The applicant may repeat the testing carried out under Condition 4g)i) using a method specifically for measuring total suspended particulate less than 10 micrograms in size (PM10) should testing for total suspended particulate levels give results that exceed 16 milligrams per cubic metre. The purpose of this shall be to demonstrate compliance with Condition 3.*
- *h) The consent holder shall forward a copy of the results of the testing to the Consent Authority within two weeks of receiving the results.*
- *i) All results shall be corrected to 0℃, 101.3 kPA, dry gas and 11% oxygen.*

6.2.2 Frequency

The frequency of stack testing of discharges from the biosolids incinerator is non-compliant with consent requirements due to limited operation.

The above consent condition requires the stack testing to be undertaken annually, in October or November. However, due to a series of technical issues and subsequent adjustments, the biosolids incinerator has being shut down and started up various times since its installation. The incinerator has now been operating since November 2015, but was only operational for short periods of time before that and after the first shut down in 2013. According to information provided by DCC, these short periods were from 6 October 2014 to 1 April 2015 (approximately 6 months) and from 13 April 2015 to 28 May 2015 (45 days). Consequently, the only stack testing to date was undertaken on January 2013, which was prior to the Tahuna WWTP upgrade in February 2013 and the full incinerator refurbishment in 2015. Accordingly, the results from January 2013 are expected to be obsolete for demonstrating current incinerator performance and were therefore not considered for this review.

6.2.3 Method

As detailed in section above, there are no stack testing results available for the current incinerator configuration, which has only been operating since November 2015. Therefore, there was no evaluation of compliance with consent requirements for the stack testing method.

6.2.4 Limits and performance

As detailed in section above, there are no stack testing results available for the current incinerator configuration, which has only been operating since November 2015. Therefore, there was no evaluation of compliance with consent requirements for limits and performance of the incinerator.

6.3 Community Odour Survey

6.3.1 Condition

Condition 6 (of Consent No. RM12.139.01.V1) states:

The consent holder shall carry out a community odour assessment survey during October or November 2015 and report the results to the Consent Authority within 3 months of the completion of the survey. The survey shall consult a random selection of people within a 1,000 metre radius of the consent holder's activities. The design and extent of the survey shall comply with recognised good practice for community surveys.

6.3.2 Frequency

The frequency of the community odour assessment survey is compliant with the consent requirements.

The survey was carried out during November 2015 and a detailed report provided to the consent authority within the required 3 months following completion of the survey.

6.3.3 Method

The method used for the community odour assessment survey is compliant with the consent requirements.

The survey[4] design was implemented following a standard protocol that has been previously implemented at numerous locations throughout New Zealand and was approved by the Otago Regional Council. The number and location of respondents also followed consent extent requirements and recognised good practice.

6.3.4 Limits and performance

There are no limits set out in consent conditions for the survey results.

Notwithstanding the above, the conclusions by Tony Dons (2015) state that "*overall there appeared to be a lesser odour impact in 2015 than in 2011 which the Dunedin City Council considers is due to the completion of the recent upgrade works*" and that "*the results show that further community odour surveys are not warranted in the foreseeable future but it is recommended that the DCC monitors odour complaint numbers and considers further odour surveys if odour complaints show a sustained increase.*" Golder has previously reviewed the survey data and report and agrees with these statements.

6.4 Odour Complaints Register

6.4.1 Condition

Condition 8 (Consent No. RM12.139.01.V1) states:

[4] Tony Dons 2015. Dunedin City Council Tahuna – Community Odour Survey November 2015. Prepared by Tony Dons Limited in association with Golder Associates (NZ) Limited. File DCC002. 17 December 2015.

The consent holder shall maintain a record of any complaints received regarding the wastewater treatment plant operation. The register shall include, but not be limited to:

a) name and location of site where the problem is experienced;
b) nature of the problem;
c) date and time problem occurred, and when reported;
d) action taken by consent holder to remedy the situation and any policies or methods put in place to avoid or mitigate the problem occurring again.

A record of the complaints shall be submitted to the Consent Authority on request. The consent holder shall advise the Consent Authority of every complaint it receives within one working day of the complaint being received.

6.4.2 Method

The odour complaint register is generally compliant with consent requirements, but has some inconsistencies that could be improved.

It generally includes the items listed in the consent condition. However, in relation to condition 8(d) – "*action taken by consent holder to remedy the situation and any policies or methods put in place to avoid or mitigate the problem occurring again*" – the comments section of the register does not always include this information. There are a number of complaint records for which odour from the Tahuna WWTP and the cause was confirmed, but which do not list actions taken to mitigate or prevent the problem. DCC have provided further information that indicates actions have been taken to this end in relation to the main causes of odour complaints. Therefore, it is considered that the intent of the condition is being complied with. It is recommended that the complaint register is modified to include this information. Additionally, the complaint register only had one column for "Date", which includes date and time, and in some cases the comments section indicates when the complaint was received at a different date and time than when the complainant noticed the odour. It is recommended that the complaint register is amended to ensure that both are recorded in line with the consent condition requirement.

6.4.3 Frequency and sources of odour complaints

There no limits set out in consent conditions in terms of frequency of odour complaints. However, it is noted that these have increased in recent years, with 18 complaints recorded in 2014, 32 in 2015, and 31 in 2016 (up to May). As described above, although DCC has been taking actions to mitigate and prevent the causes of odour from the site, these are not always clearly identified or sufficiently detailed in the complaint register. Based on the complaints register and on additional information provided by DCC upon request, Golder understands the following were the main causes for odour complaints during different periods:

- 2013/2014: Several odour complaints related to transportation of sludge by an open removal truck. However, only one complaint due to this source has been made since late 2014, when DCC changed to a fully enclosed system for transporting sludge to the Green Island WWTP.
- Summer 2014: Several odour complaints were received which were attributed to underperformance of the Tahuna WWTP biofilters. DCC sought expert advice and made improvements to the system, including root-raking of the biofilter media, adding 200 mm bark and installing a new irrigation system. However, these measures didn't seemed to solve the problem completely, as odour complaints due to the biofilters continued to occur, albeit with a lower frequency. The biofilter media is due to be replaced in late 2016 to address this.
- February 2016: Several odour complaints were received which were attributed to underperformance of the Tahuna WWTP biofilters. DCC engaged Golder to carry out a detailed investigation and a number of recommendations were provided by Golder (2016) to avoid this problem in the future. Details about this investigation or about subsequent actions from DCC are not included in the complaint register, but there were no odour complaints between March to May 2016 that were attributed to the biofilters.
- April/May 2016: There have been four odour complaints in this period which seem to be due to the incinerator room. There is no information in the register about actions to mitigate this source.

6.5 Air Quality Compliance Statement

Overall, the Tahuna WWTP and the Musselburgh Biofilters and Generators are compliant with the consent conditions relating to its discharges to air. However, the following areas should be improved in order to demonstrate a full compliance:

1) The frequency of pressure measurements of the Musselburgh biofilters has been generally weekly from 2014 onwards, but there were a few occasions when measurements did not occur for a particular week.

2) The frequency of moisture measurements has been generally monthly from the second half of 2014 onwards, but were no moisture measurements for the eight months during November 2013 to June 2014, and for the month of October 2015.

3) The methods for monitoring the parameters of the biofilters are not included in the monitoring records.

4) The pH of the biofilters beds has not been maintained at 6 or greater, with over 50 % of measurements since June 2012 being below a pH of 6.

5) The units of pressure measurements is indicated as kPa in the monitoring results spreadsheets, but as discussed they are likely to be actually in mm of water column.

6) The frequency of the biosolids incinerator stack testing has not followed the consent requirements due to it not being operational for long periods of time as discussed above. However, there were two occasions when the incinerator was operational during the months of October and/or November (in 2014 and in 2015) and no stack testing was undertaken.

7) The design of the odour complaint register generally includes the items required under condition 8 of Consent No. RM12.139.01.V1. However, there are a number of complaints for which odour was confirmed to be from the Tahuna WWTP, but there is no information in the register about actions taken to mitigate or prevent the odour from reoccurring (although information provided separately by DCC indicates such actions have been taken). Additionally, the date/time information in the register is not always clear about whether they relate to when the complaint was received or when the complainant noticed the odour.

8) The odour complaints due to the Tahuna WWTP have been cause for concern during certain periods, but reviewed information indicates that DCC has taken actions to mitigate and prevent these odours to the extent practicable. Information also indicates that the biofilters have historically been the key cause of odour complaints due to the Tahuna WWTP.

6.6 Air Quality Recommendations

The following recommendations are made in order to address the issues raised above:

Musselburgh biofilters

1) Include a “Comment” column in the Musselburgh Pump Station Biofilter Bed Monitoring spreadsheets and note any reasons (e.g., plant shutdown, maintenance, etc.) why measurements were not carried out according to the required frequency.

2) When the plant is operational, carry out pressure measurements without skipping any weeks (i.e., any Monday-Friday periods) and, if possible, approximately on the same day of the week, avoiding intervals of 10 days or longer (e.g., measuring on a Monday in one week and then on a Friday of the following week).

3) Include the methods used for monitoring each parameter of the biofilters in the monitoring records spreadsheet.

4) Liaise with the consent authority for a variation of condition 5(b) of Consent No. 2006.825. As discussed, Golder considers that a pH of 5 or higher in the top 2/3 layer of the biofilter beds and a pH 3

or higher in the bottom 1/3 layers provide for an effective biofilters bed operation. This is set out in the recommendations by Golder (2016) for the Tahuna WWTP biofilter beds and can be used as an example for this process.

5) Confirm in which units the pressure is being measured at the biofilter fans and amend the monitoring records accordingly if necessary.

6) Liaise with the consent authority for a variation of condition 5(d) of Consent No. 2006.825. As discussed, temperature monitoring of the biofilter media or of the inlet air stream is not considered necessary given the ambient nature of the air stream being treated by the Musselburgh biofilters. This is also concluded by Kingett Mitchell (2006) and can be used for this process.

7) Include the recommended limits listed below as a reference in the monitoring records spreadsheet. Although these are not required by consent conditions, they should be used to trigger any corrective or preventive actions in case one of the measured parameters indicates a deterioration of the biofilters performance.

   - Discharge pressure measured at the fans: below 200 mm of water column.
   - Moisture: between 50 wt. % to 65 wt. %.
   - Air extraction rate: below approximately 2.9 m^3/s. This is based on the recommended upper limit air loading rate of 60 m^3_{air}/h per m^3_{media} for the Musselburgh biofilters and considering the two beds have a total combined media volume of approximately 173 m^3.

Biosolids incinerator

8) Program and undertake a stack testing of the biosolids incinerator in October or November of 2016, making sure all requirements of condition 4 of Consent No. RM12.139.01.V1 are met in terms of the methods, monitored parameters, number of tests and operational conditions during testing.

9) Collate the future stack testing results along with detailed records regarding the history of shut downs, start-ups and refurbishment of the incinerator. This will help to clearly demonstrate compliance with conditions 3 and 4 of Consent No. RM12.139.01.V1 once the incinerator has been operating regularly.

Community ddour survey

10) Monitor number of odour complaints and consider further odour surveys if there is a sustained increase in complaint numbers.

Odour complaint register

11) Include details about investigations and actions taken to remedy and to mitigate or prevent the problem from occurring again following confirmed odour complaints. These should include but not be limited to: reference to any specific documents prepared as a result of odour complaints; summary of key findings from investigations; details of actions being taken and progress on these; details about any modifications to policies or management plans undertaken as a result of odour complaints and/or investigations.

12) Include separate sections for date/time when complaint was received and for when the complainant identified the odour, so that these are easily identified in the register.

Sources of odour complaints

13) The biofilter media is due to be replaced in late 2016 to prevent the Tahuna WWTP biofilters from being a source of odour complaints in the future.

14) If odour complaints continue to be attributed to the incinerator room, engage a qualified specialist to investigate the causes and possible solutions to prevent this from reoccurring.

7.0 STAKEHOLDER CONSULTATION

7.1 Liaison Group

The liaison group comprises the following members:

- Department of Conservation (DoC)
- St Clair Surf Lifesaving Club Inc
- St Kilda Surf Lifesaving Club
- Brighton Surf Lifesaving Club
- Public Health South/Southern District Health Board
- DCC Environmental Health
- South Coast Board Riders Association (Inc)
- Surfing New Zealand
- Kai Tahu ki Otago Limited (KTKO)
- Te Runanga o Otakou

DCC has advised that an annual meeting with the liaison group typically takes place in August/September, usually with low turnout (typically just DoC and Public Health South). Following discussions with DCC it was decided that rather than holding a meeting the consultation would be done via a letter and flyer containing a summary of findings from the Stage 1 data review. A copy of the letter and flyer is provided in Appendix C.

Feedback was received from two groups: KTKO and DoC.

KTKO was primarily concerned with exceedances of the wastewater flow rates and agreed that work is required to determine improvements in the wastewater treatment process. They did not consider that adjusting consent limits was appropriate, although Golder notes that this would only be recommended if the current consent limit is inappropriate for the treatment process/nature of the discharge. They expressed concern at the monitoring results in the shellfish surveys and would like to be involved in discussions on future actions.

DoC was primarily concerned with the effects of the discharge on wildlife on the peninsula and the effects of faecal coliforms on shellfish and generally questioned the evidence to support the claim of no adverse effects. They acknowledged that faecal coliforms in mussels could be due to gull or seal colonies and questioned whether any facecal source tracking work had been undertaken to determine the source. They also noted that exceedances of faecal coliform limits had occurred at control sites expressed concern at fatty deposits that have washed ashore on occasions.

Golder recommends that DCC provides a copy of the final report to KTKO and DoC and advises other members of the Liaison Group that the report is available on request.

7.2 Iwi Consultation

Consultation with iwi is an ongoing process over and above the membership of the Liaison Group referred to above. DCC has commenced the setting up of an Iwi Protocol, as required under condition 15(b) and this is awaiting input from KTKO. In addition, DCC has a number of models for consultation with iwi, outlined below:

1) The 2006 MOU with the two Runanga and the DCC – provides a high level framework to give effect to statutory responsibilities and provide opportunities for Maori participation in DCC's decision making process.

2) The Maori Participation Working Party: a direct line of communication between the DCC, Ngai Tahu runanga and Taurahere to facilitate communication and understanding at the executive / governance level of the parties and provide a forum for discussion of strategic level issues. The updated work programme is provided to this working party quarterly. If there is interest in a particular project, Corporate Policy refers back to the DCC staff member responsible for that project.

3) The Resource Consents Iwi MOU (2014) - this governs the protocols and processes for RMA matters. This MOU was developed because there are specific consultation requirements for the resource consent process under the RMA.

4) Te Roopu Taiao – members from all the councils and runanga in the wider Otago region (Councillor/CE level).

DCC has advised that despite a concerted effort to engage with KTKO, the Iwi Protocol has not yet been completed. The review recommends that DCC continues to work on completing the protocol but that it should also document the process that has been undertaken thus far, which could be provided to ORC if requested to demonstrate the efforts made.

8.0 PERFORMANCE SUMMARY AND RECOMMENDATIONS

8.1 Compliance

Wastewater quality

In relation to wastewater compliance the following key matters summarise the outcomes of this review:

- Fortnightly sampling since 2012 has shown that nine of 19 parameters with compliance limits had some non-compliance over the period that effluent data was examined (four years). Of the nine parameters, one (total aluminium) had a limit that did not appear to be environmentally based.
- Six monthly effluent quality sampling has been carried out as required since 2012 (the dataset provided). Some analysis have been carried out using different detection limits reducing the value of the data collected.
- Annual toxicity testing has been carried out as required by the resource consent conditions.

A number of recommendations have been made to remove a number of parameters from the effluent monitoring required by condition 5.

- Remove aluminium and chromium 3+ from the routine effluent monitoring program.
- Remove the trace elements arsenic, antimony, boron, cobalt, manganese, molybdenum, selenium, thallium and vanadium from the six monthly sampling program required by Condition 5e,
- Remove the VOC screen, formaldehyde, phenol and organo-tin compounds from the list of analytes required by Condition 5e.

In addition, if there is no evidence of the final discharge having resulted in O&G related slicks at the discharge or being responsible for the presence of fat particles at the shore a change to the O&G compliance limit is recommended. This will require a re-evaluation of the last few years O&G data.

The timing and need for final discharge pathogen sampling and testing should be reviewed with the goal of providing a sampling basis that has a more public health focus.

Shoreline water and shellfish quality (microbiology)

Consent condition 6d requires that any faecal coliform numbers in mussels above 300 MPN/100 g be notified to the ORC. Exceedences of the limit have occurred a total of 23 times at six of the shoreline monitoring

locations. Similar frequencies of exceedance have occurred at the control site compared to all other sites. These results have been reported to ORC.

Shellfish quality (trace elements)

Shellfish quality sampling for trace elements undertaken has been compliant with the requirements of the resource consent. Concentrations of a range of trace elements have been measured for over a decade in green lipped mussels. The resource consent does not contain any specific compliance matters relating to shellfish contaminant quality.

Rocky shore ecological survey

Rocky shore monitoring at areas surrounding the Tahuna WWTP outfall has been undertaken for up to twenty years, across a number of sites. No significant differences in rocky shore algae or animal communities has been observed in relation to the outfall across this time. Because natural variability any small potential effects on these communities are not likely to be observed or determinable. It is unlikely the Tahuna Outfall is having any adverse effects on the rocky shore community at sites adjacent to the outfall.

The review has recommended that the frequency of rocky shore monitoring be reduced to once every five years but included sampling in the following year should significant differences by identified.

Benthic ecological survey

Sampling has been undertaken to meet the condition of consent. The results from the post-commissioning surveys and comparisons with pre- commissioning surveys indicate that there are no significant impacts to subtidal benthic communities that are attributable to the outfall.

Benthic sediment quality survey

Benthic sediment sampling has been carried as required by the resource consent and subsequent variations to the sampling method as agreed with ORC. Sampling has been undertaken every year as required by the consent. Examination of the data has shown that there is no evidence of any anomalous data that would suggest obvious contamination from the discharge. The data suggest that small variations in inter-year concentrations may obscure the detection of small changes in sediment concentration that might be due to outfall contributions. Trends and differences over time at any location will only able to be detected using replicated sampling. In its absence the value of the survey is significantly reduced (refer recommendations below).

Air quality

Overall, the Tahuna WWTP and the Musselburgh biofilters and generators are compliant with the consent conditions relating to its discharges to air. A number of matters were identified where compliance improvements could occur:

1) Improving the frequency of pressure measurements of the Musselburgh biofilters

2) Improving the frequency of moisture measurements carried out at the Musselburgh biofilters.

3) Improving the management of pH in the biofilters beds to ensure they stay above pH 6.

5) Ensuring consistency of unit reporting.

6) Ensuring that stack testing is carried out as required.

7) Ensuring that information recorded in the complaints register is complete.

8.2 Recommendations

Influent to WWTP

The assessment of influent data queries why aluminium was included in the analysis being undertaken and queried whether it could be deleted.

The assessment queried why the trace element analysis of influent had ceased with the exception of trivalent chromium. It was recommended that the re-instatement of trace element monitoring of influent be re-considered. If monitoring recommenced, a 24 hour composite sample collected every two months would be recommended.

Effluent monitoring

The evaluation of the six monthly effluent sampling recommended that the method of sampling for VOCs be reviewed and that the need to include all trace elements in the analysis undertaken be reviewed.

Shoreline water and shellfish quality (microbiology)

That the reporting of contact recreational water quality information (derived from the shellfish gathering suitability water quality survey using faecal coliforms) not be reported in the annual shellfish reports.

The review identified that there is no evidence of the source or sources of elevated bacterial numbers that have been reported in edible shellfish. As the program is an extensive monitoring program, it is recommended that the faecal coliform shoreline monitoring be discontinued if the shellfish bacterial monitoring continues. It was also recommended that source tracking be undertaken to attempt to elucidate the sources of measured bacteria in water/shellfish. The results should assist in a review of the future need of the shoreline water and shellfish microbiological monitoring.

It is recommended on the basis of results obtained to-date that the enterovirus in shellfish testing be removed from the program.

Shellfish quality (trace elements)

It is unlikely that ongoing shoreline green-lipped mussel sampling will identify changes in trace element concentrations derived from the WWTP discharge. Consideration should be given to changing the frequency of the sampling programme (to every two or five years) or removing the shellfish assessment from the monitoring programme.

Rocky shore ecological survey

Recommendations made in relation to the shoreline ecological monitoring included:

- Frequency of Rocky Shore monitoring be reduced to once every five years. If significant differences in communities are observed, then a repeat survey is to be undertaken the following year.
- Standardisation of the location of ‘low tide’ within each site. This will ensure that any differences observed are as a result of differences in communities, not a change in location up or down the intertidal.

Benthic ecology

Recommendations were made to improve the ability to detect inter-site differences by collecting replicate samples at each monitoring station. However as the benthic ecological survey is a substantive monitoring program recommendations were made to reduce the overall sampling effort by identifying focus sites. Following two years of sampling, results should be reviewed and sampling then carried out in three years and then on a five year sampling period.

In addition:

- Reduce the sampling effort through the ‘holding’ of samples, with the intention that they be processed if results of remaining sites indicate a potential effect.
  - Collect replicate samples from each site, as has been undertaken previously. Preserve all samples.
  - Process and analyse benthic communities from Sites 10, 50, 250 and 2000, both east and west of the outfall.
  - Hold the remaining samples for processing at a later date, should this be required.

- Include the methods used to differentiate between dead and alive foraminiferans specimens; the use of stain, such as rose Bengal, is recommended to increase the visibility of small invertebrates within the samples to increase sorting accuracy (if not being used).

Benthic sediment quality survey

Recommendations were made to consider changes to the sediment sampling and assessment survey to increase the information value of the results obtained. These included:

- Collect sufficient sediment to allow the <0.063 mm sediment fraction to be separated from the whole sample and analyse this sediment fraction. Aluminium should still be included in the analysis as a reference element.
- Replication should be brought back into the programme to allow inter-site differences to be assessed.
- The programme should be carried out with the corresponding benthic ecology monitoring sampling round, then the results reviewed and if no significant differences in the concentrations of key elements in the fine sediment fraction are detected, then the frequency should be reduced in line with the benthic ecological monitoring.

Air quality

A number of recommendations were made in relation to the Musselburgh pump station biofilters. Recommendations were made in relation to the monitoring of odour complaints, the functionality of the odour register and technical matters related to managing particular odour issues.

9.0 REPORT LIMITATIONS

Your attention is drawn to the document, “Report Limitations”, as attached in Appendix D. The statements presented in that document are intended to advise you of what your realistic expectations of this report should be, and to present you with recommendations on how to minimise the risks to which this report relates which are associated with this project. The document is not intended to exclude or otherwise limit the obligations necessarily imposed by law on Golder Associates (NZ) Limited, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

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APPENDIX A

Resource Consents 2002.623, RM123190V1, 2006.825

Annexure 1:

- **Recommended text and consent conditions to the Minister and**
- **Text and conditions of permits granted.**

Recommendations: That the Minister of Conservation grants to Dunedin City Council

I Coastal Permit and Restricted Coastal Activity 2002.623:

To discharge up to 600 litres per second average dry weather flow and up to 4,000 litres per second wet weather flow of treated wastewater to the Pacific Ocean from an outfall located approximately 1100 metres offshore

for the purpose of disposal of treated wastewater from Dunedin City

for a term expiring on 30 June 2032.

Location: the outfall commences at the Tahuna Waste Treatment Plant situated at 10 Tahuna Road and extends approximately perpendicular to the shore to a distance of 1,100 metres from mean high water springs.

Grid reference: Centred on diffuser: NZMS 260 I44 176 736

1. Flow Rate of Treated Wastewater Discharge

(a) The flow rate of wastewater discharged shall not exceed 600 litres per second average dry weather flow and up to 4,000 litres per second peak wet weather flow of treated wastewater.

(b) The maximum flow specified in this consent shall not be exceeded except when any exceedance is due to the effects of heavy rainfall (defined as a 1 in 2 year return period 24 hour rainfall event).

2. Diffuser

The discharge of treated wastewater into the Pacific Ocean shall be via a multiport submerged diffuser located above mobile sands and located from 1000m to 1100m from mean high water springs.

3. Wastewater Quality Standards

(a) Until 1 September 2011 the quality of the treated wastewater discharged into the Pacific Ocean shall comply with the following criteria:

Parameter	Units	Rolling 6 month Median*	Rolling 12 month 95%ile†
pH		6.0-9.0	
BOD_5	mg/l	350	600
TSS	mg/l	150	250
Oil & Grease	mg/l	60	75
Aluminium	mg/l		5
Mercury	mg/l		0.005
Cadmium	mg/l		0.05
Chromium III	mg/l		0.3
Chromium VI	mg/l		0.70
Copper	mg/l		0.07
Lead	mg/l		0.3
Nickel	mg/l		0.2
Silver	mg/l		0.01
Zinc	mg/l		0.35
Cyanide (WAD)	mg/l		0.02
Sulphide	mg/l		1.5
Ammonia	mg/l		40
Faecal coliforms	/100ml		2,200,000
To apply when disinfection is in operation			
Total Residual Chlorine	mg/l		0.50
Enterococci	/100ml	1,500	12,000

Notes:

* based on the results of any 12 consecutive fortnightly self-monitoring rounds

† based on the results of any 24 consecutive self-monitoring rounds

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(b) Until 1 September 2011 the discharge may include chlorine that has been added to the effluent. If chlorine has been used to disinfect the effluent it must be inactivated with the addition of sodium bisulphite before being discharged via the outfall. The addition of chlorine shall cease by 1 September 2011.

(c) From 1 September 2011 the quality of the treated wastewater discharged into the Pacific Ocean shall comply with the following criteria:

Parameter	Units	Rolling 6 month Median*	Rolling 12 month 95%ile†
pH		6.0-9.0	
BOD_5	mg/l	50	140
TSS	mg/l	50	140
Oil & Grease	mg/l	10	30
Aluminium	mg/l		5
Mercury	mg/l		0.005
Cadmium	mg/l		0.05
Chromium III	mg/l		0.3
Chromium VI	mg/l		0.70
Copper	mg/l		0.07
Lead	mg/l		0.3
Nickel	mg/l		0.2
Silver	mg/l		0.01
Zinc	mg/l		0.35
Cyanide (WAD)	mg/l		0.02
Sulphide	mg/l		1.5
Ammonia	mg/l		40
Faecal coliforms	/100ml	1,500	12,000
Enterococci	/100ml	1,500	12,000
Total Residual Chlorine	mg/l		0.2

THE SEAL OF THE ENVIRONMENT COURT OF NEW ZEALAND

Notes:

* based on the results of any 12 consecutive fortnightly self-monitoring rounds

† based on the results of any 24 consecutive self-monitoring rounds

(d) After 1 September 2011, beyond the mixing zone the discharge shall meet contact recreation and shellfish gathering water quality standards. This may be demonstrated numerically by modelling techniques.

4. Mixing Zones

(a) The outfall diffuser shall be constructed and operated to ensure that a minimum dilution of at least 160:1, based on a current speed of 10 cm/s, is achieved within the receiving water at the boundary of the zone of initial dilution (ZID) which shall be defined as the area with a horizontal radius of 175m at any point from the diffuser section.

(b) The consent holder shall, within two years after the exercise of this consent, verify that the dilution in the zone of initial dilution (ZID) complies with condition 4(a) above. The results of this assessment shall be forwarded to the Consent Authority no later than six months after the assessment.

(c) By 1 September 2011 the consent holder shall verify that beyond 175m from any point along the diffuser section, dilution complies with condition 3(d). The results of this assessment shall be forwarded to the Consent Authority no later than six months after the assessment.

(d) The discharge, outside of the mixing zone, shall not result in:

(i) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials

(ii) any conspicuous change in the colour or visual clarity

(iii) any emission of objectionable odour

(iv) any significant adverse effects on aquatic life.

5. Wastewater Monitoring

(a) The consent holder shall keep a continuous record of wastewater flows discharged into the Pacific Ocean and make this record available to the Consent Authority upon request.

(b) A quarterly summary of the maximum, minimum and mean flows for each calendar month (in both litres per second and cubic metres per day) shall be reported in writing to the Consent Authority by 31 January, 30 April, 31 July and 31 October each year.

(c) The consent holder shall at fortnightly intervals, collect 24-hour composite samples of the treated wastewater before chlorination and prior to discharge into the outfall. For bacteria the sample shall be a single grab sample. The samples shall be analysed for the parameters for which treated wastewater standards have been set in the table in condition 3. This monitoring data shall be forwarded to the Consent Authority every three months by 31 March, 30 June, 30 September and 31 December of each year.

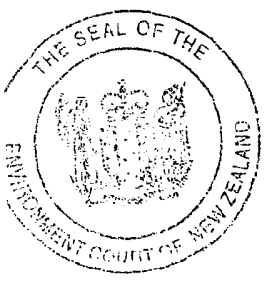
(d) During periods of chlorination, the consent holder shall collect a grab sample of the treated wastewater, prior to discharge into the outfall, every two days and at a minimum of once during every chlorination event. The samples shall be analysed for Enterococci and total residual chlorine as the parameters from condition 3, which apply when chlorination is in operation. Monitoring results shall be forwarded in writing to the Consent Authority within 10 days of the results being received.

(e) The consent holder shall at six monthly intervals, collect 24-hour composite samples of the treated wastewater before chlorination and prior to discharge into the outfall. The samples shall be analysed for: Antimony, Arsenic, Boron, Cobalt, Manganese, Mercury, Molybdenum, Selenium, Thallium, Vanadium, formaldehyde, emulsifiable oil, volatile organic compounds, semi-volatile organic compounds, phenols, and organotin compounds. The results shall be forwarded to the consent authority by 31 March and 30 September each year.

6. Environmental Monitoring

(a) (i) The consent holder shall undertake sampling of the following beach water at weekly intervals from 1 November to 31 March (inclusive) and at monthly intervals from April to October (inclusive). The samples shall be analysed for:

- St Clair Beach – enterococci
- Middle Beach - enterococci
- St Kilda Beach – enterococci and faecal coliforms
- Lawyers Head Beach – enterococci and faecal coliforms
- Tomahawk Beach West – enterococci



- Tomahawk Beach East – enterococci
- Smaills Beach- enterococci
- Sandfly Bay- enterococci

(ii) All sampling methods are to be consistent with those set out in the Ministry for the Environment and Ministry of Health Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas, June 2003.

(iii)The results of all beach water sampling are to be assessed in accordance with the requirements of the Ministry for the Environment and Ministry of Health Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas, June 2003, or any replacement editions. The consent holder shall follow actions required by the Microbiological Water Quality Guidelines at all times. If alert/amber or action/red modes are reached, the Otago Medical Officer of Health, Dunedin City Council Environmental Health, Otago Surf Lifesavers Association and the Consent Authority shall be informed by the consent holder as soon as practicable and the sample results shall also be supplied. Resampling shall continue once every 24 hours until bacterial levels subside below the alert/amber levels.

(iv)The monitoring results of all weekly beach water monitoring shall be reported in writing to the Consent Authority and Public Health authorities at monthly intervals by 31 December, 31 January, 28 February, 31 March and 30 April each year.

(v).The results of the monthly beach water monitoring undertaken during April to October shall be reported in writing to the Consent Authority, Otago Medical Officer of Health and Dunedin City Council Environmental Health, at approximately three-monthly intervals by 31 August and 31 October each year.

(b) (i) In addition to the beach water monitoring in condition 6(a) above, the consent holder shall carry out daily observations of local, New Zealand and Pacific weather patterns to determine, so far as practicable, the expected direction of dispersal of the wastewater plume. The daily monitoring of weather patterns is to continue until chlorination ceases under condition 6(b)(iii) below, or until September 2011, whichever date is the earlier.

(ii) The consent holder must carry out daily sampling for enterococci at St Clair Beach and St Kilda Beach or at Tomahawk Beach West, Tomahawk Beach East and Smaills Beach if it is likely that through the method in condition 6(b)(i) the treated wastewater plume will approach any of these beaches. Such daily sampling for enterococci is to continue until chlorination ceases under condition 6(b)(iii) below, or until 1 September 2011, whichever date is the earlier.

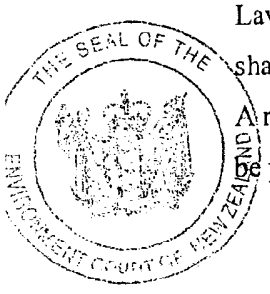
(iii) The consent holder must chlorinate continuously the primary treated wastewater whenever there is a possibility of the wastewater plume contacting St Clair Beach, Middle Beach, St Kilda Beach, Lawyers Head Beach, Tomohawk Beach West, Tomohawk Beach East and Smaills Beach. Such chlorination must be undertaken once the outfall is commissioned until an alternative disinfection procedure is in place, or until 1 September 2011, whichever date is the earlier.

(c) The consent holder shall undertake biological rocky shore monitoring annually, at Blackhead, Second Beach, Lawyers Head Beach, Boulder Beach, Allans Beach and Victory Beach. Monitoring methods shall be consistent with the methods employed under Coastal Permit 97530.

(d) The consent holder shall undertake microbiological monitoring as identified below:

(i) Monitoring of faecal coliform levels in both mussel flesh and the coastal waters on four occasions each year. Samples are to be collected from Blackhead, Second Beach, Lawyers Head Beach, Smaills Beach, Boulder Beach, Sandfly Bay North, Sandfly Bay South, Allans Beach, and Victory Beach. Hoopers Inlet shall be sampled for water quality only.

(ii) Monitoring of metals in mussel flesh once between April and May each year. Sampling is to be undertaken in conjunction with the faecal coliform monitoring outlined in (i) above. Samples are to be collected from Blackhead, Second Beach, Lawyers Head Beach, Boulder Beach and Victory Beach. Metal testing of the mussels shall include aluminium, zinc, silver, nickel, lead, copper, chromium III and cadmium. A record of the number and size (length) of the shellfish analysed in each sample shall be provided.



(iii) Monitoring of enteroviruses in mussel flesh on two occasions each year between the months of October-November and April-May. Sampling is to be undertaken in conjunction with the faecal coliform monitoring outlined in (i) above. Samples are to be collected from Blackhead, Second Beach, Lawyers Head Beach, Boulder Beach and Victory Beach.

The results of the monitoring in (i), (ii), and (iii) above shall be forwarded in writing to the Consent Authority within a month of sampling being undertaken. In addition, the consent holder shall notify the Consent Authority within 48 hours of becoming aware of any shellfish faecal coliform result that exceeds 330 MPN/100 gm.

(e) The consent holder shall undertake annually in March/April each year a Whole Effluent Toxicity test on representative primary treated and chlorinated wastewater samples. The testing shall be carried out using three separate organisms which are representative of different trophic levels and shall include at least 1 plankton and 1 macroinvertebrate. The methodology used shall be consistent with the first Whole Effluent Toxicity test undertaken in 2002 by the consent holder (NIWA, August 2002 "Tahuna Wastewater Treatment Plant Upgrade: Effluent Toxicity Testing").

The results of this testing shall be reported in writing to the Consent Authority by 30 September each year.

(f) The consent holder shall undertake annually, between December and February a sub-tidal sediments and benthic survey. The survey shall assess contaminants in the sediments as well as the number and types of species living in the sediments. Samples shall be collected at 10, 50, 250, 500, 1000 and 2000 metres each side of the 1100m offshore outfall and generally parallel to shore, as well as from Victory Beach, which is to be the control site. A minimum of three replicate sediment samples shall be collected from each site and analysed for total aluminium, zinc, silver, nickel, lead, copper, chromium and cadmium.

The results of this monitoring shall be reported in writing to the Consent Authority by 30 April each year.

(g) The consent holder shall every year between the months of November and April when chlorination is occurring collect a sample of the chlorinated wastewater and have it analysed for the following pathogenic micro-organisms outlined below. The sample shall be taken at the same time as one of the fortnightly samples required by condition 5(c).

- Enterovirus
- Campylobactor
- Salmonella
- Giardia
- Cryptosporidium

The results of this monitoring shall be forwarded in writing to the Consent Authority, the Otago Medical Officer of Health and Dunedin City Council Environmental Health, within a 30 day period of the sample being taken.

(h) From 1 September 2011 the consent holder shall every year between the months of November and April collect a sample of the wastewater and have it analysed for the following pathogenic micro-organisms outlined below. The sample shall be taken at the same time as one of the fortnightly samples required by condition 5(c).

- Enterovirus
- Campylobactor
- Salmonella
- Giardia
- Cryptosporidium

The results of this monitoring shall be forwarded in writing to the Consent Authority, the Otago Medical Officer of Health and Dunedin City Council Environmental Health, within a 30 day period of the sample being taken.

*7. **Sampling and Analysis Techniques***

All sampling techniques employed in respect of the conditions of this consent shall be in accordance with recognised standards and practice at the time sampling is undertaken and be acceptable to the Consent Authority. All analyses carried out in connection with the consent must be performed by an IANZ registered laboratory or otherwise as approved by the Consent Authority.

8. Signage

(a) The consent holder shall maintain signage to warn the public of the potential presence of wastewater containing human sewage. As a minimum, signage is to be maintained at St Kilda, Middle, St Clair, Tomahawk and Smaills Beaches. Signage location is to be reviewed with the Medical Officer of Health and the Consent Authority, at least every two years, in order to ensure that signage is located in those locations where a potential risk may occur.

(b) The consent holder shall comply with any lawful directions from the Medical Officer of Health in relation to preventing the outbreak or checking the spread of notifiable diseases, including the erection of special signage if appropriate.

9. Incident Reporting

The consent holder shall notify the Consent Authority, Otago Medical Officer of Health and Dunedin City Council Environmental Health as soon as practicable and within 24 hours, of the consent holder becoming aware of any exceedance of the effluent quality or receiving water limits of this permit and of any accidental discharge, plant breakdown, or other circumstances which is likely to result in an exceedance of the limits specified in this permit. The consent holder shall, within 20 working days of the incident occurring, provide a written report to the Consent Authority identifying the breach, possible causes, further investigations to be carried out if appropriate, and the steps taken or to be taken to ensure future compliance.

10. Exercise of Consent

This consent shall not be exercised concurrently with 2001.380.

11. Review of Wastewater Standards and Monitoring Conditions

Within 3 months of the second anniversary of the commencement of this consent, and within 3 months of every anniversary thereafter, the consent holder may, pursuant to Section 127 of the Resource Management Act 1991, apply to the Consent Authority for a review of conditions relating to the Wastewater Quality Standards, Monitoring and Environmental Monitoring, and reporting.

12. Review

The Consent Authority may in accordance with Section 128 and 129 of the Resource Management Act 1991 serve notice on the consent holder of its intention to review the conditions of this consent within three months of each anniversary date of this consent for the following purposes:

a) to deal with any adverse effect on the environment which may arise from the exercise of this consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent, or

b) to adopt the best practicable option to remove or reduce any adverse effect on the environment, or

c) to comply with the requirements of a relevant rule in an operative regional plan, or

d) to deal with the results of the mixing zone monitoring required by condition 4(b) and (c) of this consent.

13. Operations and Management Manual

(a) Within six months of the commencement of this consent, the consent holder shall, after consultation with the manager who is responsible for consent compliance at the Consent Authority, prepare and forward to the Consent Authority an Operations and Management Manual for the treatment and disposal system to ensure its effective and efficient operation at all times, and for compliance with consent conditions. The system shall be operated in accordance with this Manual. The Manual shall include:

(i) a description of the entire treatment facility, including, but not limited to, wastewater treatment and management systems; wastewater disinfection; sludge treatment and management systems; air treatment and disposal systems; discharge location(s), and monitoring sites

(ii) a description of the procedures for ensuring defined routine maintenance requirements are carried out

(iii) a description of procedures to monitor the treatment plant operations as well as the procedures for recording and reviewing all monitoring data and information

(iv) specific management procedures for key components of the system

(v) contingency plans to prevent and deal with unusual events

(vi) other actions necessary to comply with the resource consents associated with the ongoing operation of the Tahuna Wastewater Treatment Plant

(vii) procedures for improving or reviewing the Operations and Management Manual

(viii) the criteria that will be considered, and the procedures for introducing chlorination, and dechlorination .

(ix) A description of the procedures for carrying out observations of local, New Zealand and Pacific weather patterns which may affect the direction of the plume of treated wastewater discharged under this consent, the means by which such observations and forecasts based on those observations will be recorded and the duration for which such records shall be held.

(b) The consent holder shall update the Operations and Management Manual when there are any significant changes or upgrades to the Tahuna Wastewater Treatment Plant's operation. The need for such an update shall be assessed at least once every year and reported to the Consent Authority.

(c) The consent holder shall ensure that the Operations and Management Manual is available for viewing by the Consent Authority and interested parties on request in writing or at such other time as is agreeable to all appropriate parties.

(d) The consent holder shall operate and maintain the Tahuna Wastewater Treatment Plant in accordance with the Operations and Management Manual.

14. Monitoring and Upgrade Report

(a) At the 3rd anniversary of the first exercise of this consent, and every five years thereafter, the consent holder shall undertake a comprehensive assessment of the wastewater discharge to determine options for, and appropriateness of upgrading treatment and disposal processes. In undertaking this assessment, the consent holder shall consider, but not be limited to, the following:

(i) the results and associated assessment of monitoring undertaken in accordance with all the resource consents associated with the Tahuna Wastewater Treatment Plant, including the: Wastewater Quality Monitoring; Contact Recreation Water Quality Monitoring; Microbiological and Metal Testing of Shellfish; Biological Rocky Shore Monitoring; Whole Effluent Toxicity Monitoring; Sub-tidal Sediments and Benthic Monitoring; and, Air Discharge Monitoring.

(ii) technological changes and advances that may be applicable to the ongoing operation of the plant

(iii) ongoing compliance with all of the resource consents associated with the Tahuna Wastewater Treatment Plant

(iv) the implications of policy and legislative change of relevance to the ongoing operation of the plant

(v) the cost of any upgrade options, in the context of the Long Term Council Community Plan

(vi) any changes to the waste stream entering the Tahuna Wastewater Treatment Plant.

(b) In preparing the report, the consent holder shall consult with Iwi, the Liaison Group and the Consent Authority and assess the issues raised during consultation.

(c) The consent holder shall submit a report to the Consent Authority by 30 September in the year that the assessment is undertaken. The report shall outline, but not be limited to, the following information:

- the report preparation process
- issues considered
- the outcome of the assessment
- implementation stages and associated timing of any proposed upgrade
- implications with regards to any existing resource consent conditions
- comment on each of the points in Condition 14(a), as a minimum

15. Liaison Group and Iwi Collaboration

(a) The consent holder shall establish a Liaison Group which shall include representatives of the local community, Department of Conservation, the Otago Surf Lifesaving Association, Public Health South and other interested groups. The Liaison Group shall meet at least annually to discuss and review the exercise of all the resource consents associated with the ongoing operation of the Tahuna Wastewater Treatment Plant. This shall include, but not be limited to, the following:

- the general performance of the Tahuna Wastewater Treatment Plant and the discharge including any changes to its operation

- the results of all monitoring and the associated assessment of the monitoring information carried out in accordance with the conditions attached to this consent
- the annual report prepared in accordance with condition 17 of this consent.
- the review by the consent holder of the options discussed and chosen, to upgrade treatment processes at the Tahuna Wastewater Treatment Plant,
- consideration of other issues raised by Liaison Group members

(b) The consent holder, in conjunction with the Te Runanga o Otakou, shall develop a Protocol within three months of the granting of this consent. The Protocol shall include, but not be limited to, the following matters:

- a commitment to ongoing co-operation between the parties; and
- Te Runanga o Otakou involvement, as part of a co-operative approach, in the development and review of monitoring undertaken in accordance with these consents; and
- Te Runanga o Otakou involvement, as part of a co-operative approach, in the Monitoring and Upgrade Report required by Condition 14.

(c) The consent holder shall meet at least annually with Iwi representatives, in accordance with the Protocol, to discuss and review the exercise of all the resource consents associated with the ongoing operation of the Tahuna Wastewater Treatment Plant and the discharge. This shall include, but not be limited to, the following:

- the general performance of the Tahuna Wastewater Treatment Plant and the discharge including any changes to its operation
- the results of all monitoring and the associated assessment of the monitoring information carried out in accordance with the conditions attached to the resource consents
- the annual report prepared in accordance with the conditions of the resource consents
- the review by the consent holder of the need, or otherwise, to upgrade treatment processes at the Tahuna Wastewater Treatment Plant
- consideration of other issues as raised by Iwi.

Copies of the minutes from the liaison groups and Iwi meetings undertaken in accordance with this condition shall be forwarded to the Consent Authority by 30 September each year.

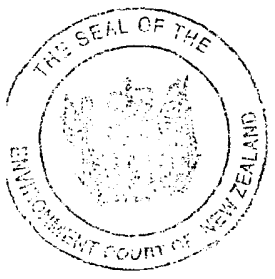
16. Complaints Register

The consent holder shall maintain a register of complaints pertaining to all aspects of the treatment and disposal of treated wastewater from the Tahuna Wastewater Treatment Plant and the discharge. The register shall detail the name of the complainant, date, time and type of complaint, cause of complaint and action taken by the consent holder in response to the complaint. The register shall be made available to the Consent Authority upon request.

17. Annual Reporting

The consent holder shall forward to the Consent Authority a written report, covering the period 1 July to 30 June, by 30 September of each year covering all the resource consents associated with the ongoing operation of the Tahuna Wastewater Treatment Plant and the discharge. The annual report shall include, but not necessarily be limited to the following:

- results of all monitoring undertaken in accordance with the requirements of the Tahuna Wastewater Treatment Plant resource consents
- comment on compliance and non-compliance with resource consent conditions and a discussion on any action taken in relation to non-compliance
- a summary of complaints received, the validity of the complaint and the corrective action taken
- any works that have been undertaken to improve the performance of the treatment systems or that are proposed to be undertaken in the upcoming year
- actions that have been carried out to reduce the entry of stormwater into the sewerage system
- any other issue considered relevant by the consent holder



Dated at Wellington this 6 day of October 2004

Hon Chris Carter
Minister of Conservation

ORIGINAL

Otago Regional Council

Our Reference: A527889

Consent No. RM12.139.01.V1

DISCHARGE PERMIT

Pursuant to Section 104B of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: 50 The Octagon, Dunedin

To discharge contaminants to air for the purpose of operating the Tahuna Wastewater Treatment Plant

For a term expiring: 3 July 2048

Location of consent activity:
10 Tahuna Road, Dunedin

Legal description of consent location:
Part Sec 28 Blk VII Otago Peninsula SD, Lot 1 DP 21573, Sec 1 SO 360224, Sec 2 – 3 SO 431393

Map Reference: NZTM2000 E1407814 N4913554

Conditions
Specific

1. This consent shall not commence until Discharge Permit 2002.625 has been surrendered or has expired.

1A. Operation of the 1 megawatt diesel powered emergency generator shall be limited to emergency purposes and for up to 3 hours per calendar month for testing purposes. All discharges from the emergency generator shall be from a vertical stack at least 14.8 metres above ground level.

2. There shall be no discharge at or beyond the boundary of the site as a result of the exercise of this consent that is noxious, dangerous, offensive or objectionable to the extent that it causes an adverse effect in the opinion of an authorised officer of the Consent Authority.

3. The concentration of contaminants in the air discharge from the biosolids incinerator, prior to discharge to the biofilters, shall not exceed the following:

Contaminant	Limit
Suspended particulate matter less than 10 micrograms in size (PM_{10})	16 milligrams per cubic metre
Sulphur Dioxide	50 milligrams per cubic metre
Oxides of Nitrogen	200 milligrams per cubic metre as NO_2
Hydrogen Chloride	10 milligrams per cubic metre
Hydrogen Fluoride	2 milligrams per cubic metre
Mercury	0.1 milligrams per cubic metre
Total Cadmium and Thallium	0.1 milligrams per cubic metre
Total Antimony, Arsenic, Lead, Chromium, Cobalt, Copper, Manganese, Nickel, and Vanadium	0.5 milligrams per cubic metre
Dioxins and Furans (PCDD/Fs)	0.1 nanograms (toxic equivalents) per cubic metre

All concentrations are corrected to 0°C, 101.3 kPA, dry gas and 11% oxygen.

Performance Monitoring

4. The consent holder shall measure the discharges from the biosolids incinerator to demonstrate compliance with the limits for each contaminant listed in Condition 3. The monitoring shall be undertaken in accordance with the following:
   a) Samples shall be collected downstream of the scrubber system and prior to the discharge entering the biofilter.
   b) The test shall be undertaken annually, in October or November;
   c) Each test shall comprise three measurements and shall be undertaken as far as practicable when the incinerator is working at least 75% of the maximum biosolids combustion rate. Compliance shall be measured against the arithmetic mean of the three results;
   d) The consent holder shall record the plant's biosolids combustion rate, expressed as a percentage of maximum rate, during the tests;
   e) Results shall be measured as hourly averages with the exception of dioxins and furans, which shall be measured as three-hour averages.
   f) The toxic equivalents for dioxins and furans (TEQ) shall be determined from World Health Organisation (1997) toxic equivalency factors and one half of the limit of detection shall be included in the TEQ calculations for those congeners below the detection limit.
   g) When monitoring for suspended particulate matter less than 10 micrograms in size (PM_{10}), the following shall apply:

i. The applicant shall follow method ISO 9096:2003, USEPA Method 17, USEPA Method 201A, or an equivalent method as agreed in writing with the Consent Authority.

ii. Where total suspended particulate is measured under Condition 4g)i), it shall be assumed that all of the total suspended particulate measured is less than 10 micrograms in size (PM_{10}).

iii. The applicant may repeat the testing carried out under Condition 4g)i) using a method specifically for measuring total suspended particulate less than 10 micrograms in size (PM_{10}) should testing for total suspended particulate levels give results that exceed 16 milligrams per cubic metre. The purpose of this shall be to demonstrate compliance with Condition 3.

h) The consent holder shall forward a copy of the results of the testing to the Consent Authority within two weeks of receiving the results.

i) All results shall be corrected to 0°C 101.3 kPA, dry gas and 11% oxygen.

5.

a) Within six months of the commencement of this consent, the Consent Holder shall prepare and forward to the Consent Authority an Air Discharge Management Plan (ADMP) for the effective and efficient operation of process air extraction and biofilter treatment systems at the Tahuna Wastewater Treatment Plant to ensure compliance with the conditions of this consent. The ADMP shall include, but not be limited to:

i. definition of personnel roles and responsibilities;
ii. description of key contaminant-generating processes;
iii. description of the air contaminant extraction and biofiltration systems;
iv. monitoring parameters including frequency, trigger levels, and recommended actions;
v. maintenance programme for the air extraction and biofilter systems;
vi. contingency plans and responses to deal with abnormal events; and
vii. procedures for reviewing the ADMP.

b) The Consent Holder shall update the ADMP when there are any significant changes or upgrades to the Tahuna Wastewater Treatment Plant's operation. The need for such an update shall be assessed at least once every year and reported to the Consent Authority in May.

c) The Consent Holder shall ensure that the ADMP is available for viewing by the Consent Authority and interested parties on request in writing or at such other time as is agreeable to all appropriate parties.

d) Consent Holder shall operate and maintain the Tahuna Wastewater Treatment Plant in accordance with the ADMP.

e) The ADMP may be incorporated into another management plan, such as the Tahuna Wastewater Treatment Plant Operations and Management Manual.

f) The ADMP should refer to relevant standard operating procedures, site repair and maintenance procedures and other relevant documentation.

6. The consent holder shall carry out a community odour assessment survey during October or November 2015 and report the results to the Consent Authority within 3 months of the completion of the survey. The survey shall consult a random selection of people within a 1,000 metre radius of the consent holder's activities. The design and extent of the survey shall comply with recognised good practice for community surveys.

7. The consent holder shall distribute a community newsletter to all properties within 500 m of the Tahuna Wastewater Treatment Plant once per year and provide a copy to the Consent Authority within one month of being distributed. The newsletter is to contain, at least, a brief report on the operation of the wastewater treatment plant, a description of any air emission issues experienced during the year and their resolution and details of the method for lodging any air emission complaints with the consent holder including any relevant telephone numbers.

8. The consent holder shall maintain a record of any complaints received regarding the wastewater treatment plant operation. The register shall include, but not be limited to:
   a) name and location of site where the problem is experienced;
   b) nature of the problem;
   c) date and time problem occurred, and when reported;
   d) action taken by consent holder to remedy the situation and any policies or methods put in place to avoid or mitigate the problem occurring again.

   A record of the complaints shall be submitted to the Consent Authority on request. The consent holder shall advise the Consent Authority of every complaint it receives within one working day of the complaint being received.

General

9. The consent holder shall notify the Consent Authority as soon as practicable of any plant malfunction or breakdown that results in an abnormal discharge. The consent holder shall ensure that any malfunctions in control systems are repaired as soon as possible.

10. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within three months of each anniversary of the commencement of this consent, and on receiving any monitoring results under Conditions 4, 6 and 8 of this permit, for the purpose of:
   a) Determining whether the conditions of this permit are adequate to deal with any adverse effect on the environment which may arise from the exercise of the permit and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the permit; or
   b) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or
   c) Ensuring the discharge limits are appropriate and take into consideration appropriate methods to reduce particulate discharge; or
   d) Amending the monitoring programme to be undertaken, including any requirement for community odour surveys; or
   e) Adding or adjusting compliance limits for the parameters that are analysed in the samples taken under Condition 4 of this permit; or
   f) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this permit.

ORIGINAL

Otago Regional Council

Notes to Consent Holder

1. *If you require a replacement permit upon the expiry date of this permit, any new application should be lodged at least 6 months prior to the expiry date of this permit. Applying at least 6 months before the expiry date may enable you to continue to exercise this consent until a decision is made, and any appeals are resolved, on the replacement application.*

Issued at Dunedin this 1st day of August 2013
Reissued at Dunedin this 29th day of January 2015 to insert condition 1A

Christopher P Shaw
Manager Consents

Otago Regional Council

Consent No: 2006.825

DISCHARGE PERMIT

Pursuant to Section 104B of the Resource Management Act 1991, the Otago Regional the Council grants consent to:

Name: Dunedin Council City

Address: 50 The Octagon, Dunedin

to discharge contaminants (including odour and products of combustion from two 550 kilowatt diesel-fired generators) to air

for the purpose of operating the Musselburgh Pumping Station

for a term expiring 1 April 2032.

Location of activity: The southwest corner of the intersection of Rona Street and Ravelston Street, Musselburgh, Dunedin.

Legal description: Pt Lot 7 DP 1459

Map Reference: NZMS 260 I44:170-755

Expired 31/5/07

Conditions:

1. This consent shall not commence until consents 97110 and 98448 have been surrendered or have expired.

2. Any discharge shall be in accordance with the application for consent, received by the Consent Authority on 30 November 2006.

3. There shall be no discharge of odour, particulate matter or smoke as a result of the exercise of this permit that is noxious, dangerous, offensive or objectionable, at or beyond the boundary of the site in the opinion of an authorised officer of the Consent Authority.

4. The consent holder shall advise the Consent Authority of every complaint it receives within 1 working day of receiving the complaint. The consent holder shall keep a register of every complaint. The record of complaints shall be reported to the Consent Authority once every year from the commencement of this consent. The record shall include but not be limited to the following:

(a) the time and place the complaint was generated;
(b) the nature of the complaint;
(c) operating conditions at the time of the complaint, including any breakdowns of control equipment;
(d) wind conditions at the time of the complaint; and
(e) actions taken by the consent holder to address any adverse effects and minimise the risk and extent of recurrence of the causes of the complaint.

5. The consent holder shall adopt the best practicable option to avoid or mitigate any potential adverse effects on the environment arising from discharges from the consent holder's activities. This shall include, but not be limited to the following:
(a) ensuring all significant odour sources are enclosed and ventilated to odour control equipment at all times and that odour control equipment is maintained in good working order;
(b) biofilter media pH shall be measured and recorded once every 3 months from the commencement of this consent and be maintained at pH 6 or greater;
(c) biofilter media moisture content shall be measured and recorded using gravimetric analysis once every month, from the commencement of this consent;
(d) biofilter media temperature shall be measured and recorded once every month, from the commencement of this consent;
(e) overall biofilter bed and distribution pipe-work pressure shall be measured and recorded weekly, from the commencement of this consent;
(f) the total air extraction rate (cubic metres per second) to the biofilter beds shall be measured and recorded once every month, from the commencement of this consent;
(g) once every year from the commencement of this consent, the consent holder shall undertake maintenance and timing inspections of the diesel generators.

The consent holder shall forward a record of the results of all monitoring and inspections undertaken in accordance with this condition, and any interpretation of the results, to the Consent Authority annually, from the commencement of this consent, or on request.

Otago Regional Council

6. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within one month of each anniversary of the commencement of this consent for the purposes of:
   (a) determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which is appropriate to deal with at a later stage; and
   (b) ensuring that the conditions of this consent are consistent with any National Environmental Standards; and
   (c) requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 13th day of July 2007

Christopher P Shaw
Manager Consents
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APPENDIX B

Stage 1 Data Review

18 July 2016 Project No. 1657808_7401-003-L-Rev0

Chelsea McGaw
Dunedin City Council
50 The Octagon
Dunedin 9016

TAHUNA WASTEWATER TREATMENT PLANT PERFORMANCE – STAGE 1 DATA REVIEW

Dear Chelsea

Thank you for providing Golder Associates (NZ) Limited (Golder) with additional data and responding to our queries to enable us to complete the Stage 1 Data Review as part of the Tahuna Wastewater Treatment Plant (WWTP) Performance Review. The focus of the Stage 1 Data Review is on the environmental effects of the discharges and compliance with consent conditions.

We have reviewed all of the data provided to date and compiled the assessment into a summary table (water quality and ecology) attached to this letter. The air quality assessment is provided as Attachment 2.

The next two stages of the project will progress concurrently. Stage 2 will use the intelligence gathered from Stage 1 and expand it into a commentary that will be included in the Stage 4 report. The commentary will identify any monitoring that is not considered to address environmental effects of the discharge or have any meaningful benefit to Dunedin City Council (DCC) in terms of its management of the Tahuna WWTP, and will make any recommendations to changes to consent conditions that DCC might consider to improve the monitoring programme.

As mentioned in our phone conversation on Friday, we will commence work on the Stage 3 stakeholder engagement this week. We will ensure that this stage is completed with your involvement so that this part of the project benefits from the existing relationships you have with the various stakeholder groups.

Please do not hesitate to contact me to discuss any queries you may have from the Stage 1 Data Review. If needed, we can set up a teleconference with the project team.

Yours sincerely

GOLDER ASSOCIATES (NZ) LIMITED

Anna Wilkes
Senior Resource Management Consultant

AW/sb

Attachments: Stage 1 Water Quality and Ecology Data Review – Summary Table
Stage 1 Air Quality Data Review

Golder Associates (NZ) Limited
Level 1, 214 Durham Street, Christchurch 8011, New Zealand (PO Box 2281, Christchurch 8140)
Tel: +64 3 377 5696 Fax: +64 3 377 9944 www.golder.com
Golder Associates: Operations in Africa, Asia, Australasia, Europe, North America and South America

Consent condition	1. Does the monitoring frequency/parameters etc. generally meet the consent requirements?	2. Does the data generally meet any compliance limits stipulated in the consent conditions?	3. Does the data give cause for concern that the discharges may be having adverse effects on the environment
1a and 1b Flow Rate	1a Data is reported as flow in m^3/day in several years and L/s in others. 1b Requires that the maximum flow specified can be exceeded when it is due to the effects of heavy rainfall (1 in 2 year 24 hour rainfall).	Flow in L/s exceeds 600 L/s (e.g., in 2015-2016). These are assumed to be average flow based on total flow in 24 hours. The condition identified the limit as an average dry weather flow. In all cases of exceedance, there is no information as to the day being a dry or wet day. Compliance of very high flows cannot be checked as the flow information does not have corresponding rainfall records with it. In addition, the condition specifies a peak flow in L/s. The documented information only allow calculation of an average flow per second based on total daily flow. Compliance requires peak flow which requires "instantaneous" flow. **Flow definitions and data to be discussed further.**	Effects covered in quality discussion under Condition 3c
3c Discharge compliance	Sampling appears to have been carried out in accordance with the consent condition.	Some non-compliances in data (rolling limit exceedance). These includes: 2016 BOD5 6MM and 12M 95%ile 2016 TSS 6MM (all data) 2016 O&G 6MM and 12M 95%ile 2016 Total Al zero data entered into database, 12M 95%ile 2016 Total Cu 12M 95%ile	O&G refer Condition 4d Rationale for total Al in compliance measurements; Periodic very high total aluminium data. Copper key non-compliant element with 95%ile limit. **To be discussed further.**

		2016 Total Zn 12M 95%ile 2015 NC TSS 6MM (all data) 2015 O&G 6MM and 12M 95%ile 2015 Total Cu 12M 95%ile part of year 2015 Total Zn 12M 95%ile, part of year 2015 Total CN 12M 95%ile, part of year.	
3d Mixing zone compliance for microbiology	Has this been demonstrated by numerical modelling? Refer also Condition 6	N/A	N/A
4d	No evidence of visual inspections has been provided to date	N/A	O&G relates back to Condition 3c
5a and 5b Flow records	Requires continuous flow records as discussed under condition 1a and 1b. Quarterly summary of max, min and mean flows for each calendar month in L/s and m^3/day to be reported to ORC.	N/A	N/A
5c Sampling frequency	Sampling frequency complies with fortnightly sampling requirement.	N/A	N/A
5e 24 hour composite of effluent for trace elements	Sampling frequency for 2012-13 has no data so cannot assess compliance; other years mostly compliant. Sampling in October and February does not meet the 6 monthly interval.	N/A	N/A
6a(i) Beach water sampling for enterococci	Sampling completed as specified.	N/A	N/A

and faecal coliforms			
6a(ii)	All sampling methods are to be consistent with MfE (2003).	Assumed to be consistent – sampling methods not sighted.	N/A
6a(iii)	Beach microbiological assessment has been done in accordance with MfE (2003). Reporting requirements cannot be confirmed as compliant or otherwise as no details provided.	2012-13: 4 occasions >140/100 mL (alert), resampled and confirmed as 140. Lawyers Head Beach exceeded action mode, resampled over three periods between 8/1 and 5/2/13 due to exceedance of alert (140/100 mL) and action (280/100 mL) levels. 2013-14: 4 occasions >140/100 mL, resampled and confirmed as 140. 2014-15: one occasion >140/100 mL, resampled and confirmed as 140. 2015-16: All enterococci <140/100 mL.	N/A
6a(iv)(v) Beach water reporting	No evidence of reporting provided	N/A	N/A
6(c), Rocky shore ecological monitoring	The survey has been undertaken annually as stipulated. However, the methodology is said to be outlined in Coastal Permit 97530. While the frequency of monitoring is compliant, we cannot ascertain whether the methodology meets that	Yes, the data shows no observable adverse effects from the outfall on the rocky shore community.	No, the data shows no observable adverse effects from the outfall on the rocky shore community.

	stipulated in the consent because no methodology is attached to it.		
6(d)(i) Faecal coliforms in mussels and coastal waters	Data sheets for 2013-14, 14-15, 15-16 years. 2012-13 year does not appear to contain shellfish data.	Note to condition 6(d)(i-iii) requires that should any shellfish contain faecal coliforms above 330 MPN/100 g, the consent holder shall notify ORC within 48 hours. 2013-14: 4 occasions 2014-15: 4 occasions 2015-16: 12 occasions The spreadsheet contains no information confirming notification to ORC. The spreadsheets contain references to the MoH (1995) shellfish quality suitability for consumption guidance. Guidance provided by FSANZA (2001) is now *E. coli* rather than faecal coliforms. We will discuss this further in the review.	
6(d)(ii) Metals in mussel flesh.	Samples do not appear to have been collected in the requisite period in every year e.g., October 2012. Consent requires aluminium, silver to be measured – no data in spreadsheet. Chromium data presented as chromium (consent requires chromium 3). Samples should have been reported as wet weight rather	No specific compliance limits or requirements. However, comparison with food guidelines undertaken incorrectly. Better practice to measure shellfish and report median length and range	No significant implications in relation to use of dry weight information (mainly over-conservative statements in report), interpretation will be provided with review commentary.

	than dry weight and or wet to dry weight conversion information obtained.		
6d(iii) Enterovirus in mussel flesh.	Two occasions per year, Oct/Nov and Apr/May. Locations as in condition.	In 2013, samples collected in July and April In 2014, samples collected in October In 2015 samples collected in October In 2016 samples collected in April Collections in 2013 through 2015, **appear non-compliant in terms of collection period and number of occasions**.	
6(e) WET test in March/April each year	Test uses three different trophic level organisms as required by consent condition. Identifies testing of effluent and chlorinated. We have assumed that the chlorinated test was not required by 2013.	No specific compliance requirements identified in consent conditions. NIWA note dilution requirements as a benchmark (160 times) as a guide. This is a useful guidance as it provides an indication of potential effects outside of the mixing zone. April 2013 – algae/amphipod/mussel – single effluent sample June 2014 – algae/amphipod/mussel – single effluent sample May 2015 – algae/amphipod/mussel – single effluent sample April 2016 – algae/amphipod/mussel – single effluent sample	2013, 2014, 2015 effluent may have effects within zone of mixing (algae, amphipod and mussel embryo) but toxicity effects outside zone are unlikely.
6(f) Benthic ecological monitoring	Partially, subtidal benthic surveys have been undertaken annually as required. Some sampling	Evaluation based only on 2016 benthic ecology report.	No, the data indicates that there is no adverse effect from the outfall on the benthic invertebrate communities.

	events have been undertaken outside of December to February, and have been undertaken in March. However, this is not expected to have any significant effects on the sample collection or resulting data. Samples have been collected from the stipulated locations, including Victory beach.	No compliance requirements.	
6(f) Benthic sediment quality	Samples collected Dec-Feb, six sites either side of discharge parallel to shore plus a control site. Three replicate sediment samples (as noted in condition 6f) **were not collected**, instead one was collected. Samples analysed for eight elements as identified in condition. The Ryder (2016) report discussion assumes aluminium was included as an effects based contaminant.	Evaluation based only on 2016 benthic ecology report. Sediment sample collected using 200 mL container from 2-5 cm surface layer. It is assumed but not stated in Ryder 92016) that <2 mm fraction was digested for analysis. Laboratory analytical methods not sighted for any surveys.	No increase in sediment concentrations of the six of seven trace elements identified. Detection limit information not provided for silver. Aluminium data can be used as substitute for sediment grain size data which should be collected in trace element surveys, as concentrations will change depending on a number of factors including the proportion of mud present. For Cu, Cr, Pb, Ni, Zn concentrations are well related to aluminium providing an indication that much of the concentration extracted and measured is natural. Further comment on cadmium will be provided in the review.
6(h) Sampling wastewater for pathogens	Sampling undertaken annually as required.	2016: Detected enterovirus, Cryptosporidium, Giardia 2015: No detects 2014: Detected enterovirus, giardia	

1.0 MUSSELBURGH BIOFILTERS AND DIESEL GENERATORS (CONDITION 5 OF CONSENT NO. 2006.825)

1.1 Frequency

Pressure measurements (weekly)

- Status: generally compliant from 2014 onwards, but with some inconsistencies that could be improved.
- Details: Until the end of 2013, there were approximately 14 occasions when the measurements of the overall biofilter bed and distribution pipework pressure were not carried out weekly. On those occasions, intervals between measurements varied from 14 to 35 days and were 18 days on average. From 2014 onwards, the pressure measurements have been carried out approximately weekly and generally comply with the consent requirement. However there were six occasions in 2014 when the intervals were between 14 to 15 days, and one occasion in 2015 when there was a 27 day interval between pressure measurements. It is not clear if these intervals were due to plant shutdown or maintenance, or any other reason for not following the weekly measurement requirement.

Moisture, temperature and air extraction rate measurements (monthly)

- Status: compliant for temperature and air extraction rate measurements, and generally compliant for moisture measurements from the second half of 2014 onwards.
- Details: There were no moisture measurements for the eight months period between November 2013 to June 2014, and for the month of October 2015. It is noted that the temperature and air extraction rate measurements have been generally carried out on a weekly basis rather than monthly, demonstrating good practice.

pH measurements (quarterly)

- Status: compliant.
- Details: The pH measurements have been generally carried out on a monthly basis rather than quarterly, which demonstrates good practice and provides useful information for managing the performance of the biofilters.

Diesel generators maintenance and timing inspections (annually)

- Status: compliant.
- Details: Preventive maintenance check sheets of the generators have been filled out monthly from January 2013 to June 2016, which includes an inspection of the various systems (lubrication, cooling, fuel, exhaust, etc.) that constitute the generators.

1.2 Method

- Status: compliance not evaluated.
- Details: The only method required by condition 5 of Consent No. 2006.825 is the gravimetric analysis for measurement of the biofilter media moisture. It is suggested that the methods used for measuring all the biofilter parameters are included in the monitoring records.

1.3 Limits and Performance

pH measurements

- Status: Non-compliant. Performance evaluated as effective.

- Details: Condition 5(b) of Consent No. 2006.825 requires the pH of the biofilters beds to be maintained at 6 or greater. Although over 50 % of measurements since June 2012 have been below a pH of 6, nearly 93 % of all measurements have been above a pH of at least 5. Additionally, the average pH since 2014 has been of 5.7. Golder considers that a pH of 5 or higher in the top 2/3 layer of the biofilter beds and a pH 3 or higher in the bottom 1/3 layers provide for an effective biofilter bed operation. This is reflected in the recommendations by Golder (2016)[1] and also in the Air & Odour Discharge Management Plan (ADMP) of the Operations Manual for the Tahuna WWTP biofilters beds. Golder considers this recommendation is also applicable to the Musselburgh biofilters.

Pressure, moisture, temperature and air extraction rate measurements

- Status: Limits not applicable. Performance evaluated as effective.
- Details: Although condition 5 of Consent No. 2006.825 does not set limits for these parameters, recommended values for pressure and moisture are set out in the Tahuna WWTP ADMP and which Golder considers applicable to the Musselburgh biofilters as well. Additionally, a specific air loading rate limit for the Musselburgh biofilters is recommended by Kingett Mitchell (2006)[2]. The combination of these recommended values and evaluation of the measurements against them are detailed as follows:
  - Pressure: this is recommended to be below 200 mm of water column (for the discharge pressure measured at the fans). Although the monitoring results spreadsheets provided by DCC indicate the pressure measurements to be in kilopascals (kPa), based on the measured values, on discussions with DCC about the monitoring method and on information from Kingett Mitchell (2006), Golder considers it is very likely that the pressure measurements are actually in mm of water column. Assuming this is the case, all pressure measurements made at fans 1 and 2 of the Musselburgh biofilters have been below the recommended limit.
  - Moisture: preferably in the range of 50 wt. % to 65 wt. %. Nearly 60 % of all measurements to date have been within this range and are on average 61 wt. %. The minimum and maximum moisture measurements are 34 wt. % and 77 wt. %, respectively.
  - Temperature: usually periodic temperature measurements are recommended for the inlet air, as is the case with the ADMP for the Tahuna WWTP biofilters, and not for biofilter media as currently required by the consent of the Musselburgh biofilters. However, as discussed by Kingett Mitchell (2006), given the ambient nature of the air stream being treated by the Musselburgh biofilters, then temperature monitoring of the inlet air stream is not considered necessary in this instance. In any case, the temperature measurements of biofilter media have all been below 21°C and are 14°C on average. This is relatively low and well within recommended inlet air temperature of 35°C. Golder considers these measurements are not necessary and are not providing any useful information for the Musselburgh biofilters.
  - Air extraction rate: the upper limit air loading rate recommended for these particular biofilters is 60 m^3_{air}/h per m^3_{media} (Kingett Mitchell 2006). Each bed is 12 m long by 12 m wide, and has a depth of approximately 600 mm of media, equating to a total volume of approximately 173 m^3 for the two beds. This translates into a recommended total upper air extraction rate of approximately 2.9 m^3/s. From June 2012 to August 2013, the measurements were above this upper limit, being 6.7 m^3/s on

[1] Golder 2016. DCC Tahuna WWTP – Review of Biofilters. Letter from Roger Cudmore to Chris Henderson dated 9 March 2016. Golder Associated (NZ) Limited.

[2] Kingett Mitchell 2006. Assessment of Air Discharges – Musselburgh Pump Station, Dunedin. Prepared by Kingett Mitchell Limited on behalf of Dunedin City Council. November 2006.

average. This performance significantly improved from September 2013 onwards, with over 99 % of measurements of total air extraction rate being below the recommended upper limit and being 2.0 m^3/s on average.

2.0 BIOSOLIDS INCINERATOR (CONDITIONS 3 AND 4 OF CONSENT NO. RM12.139.01.V1)

2.1 Frequency

- Status: non-compliant due to limited operation.
- Details: The above consent condition requires stack testing of discharges from the biosolids incinerator to be undertaken annually, in October or November. However, due to a series of technical issues and subsequent adjustments, the incinerator has being shut down and started up various times since its installation. The incinerator has now been operating since November 2015, but was only operational for short periods of time before that and after the first shut down in 2013. According to information provided by DCC, these short periods were from 6 October 2014 to 1 April 2015 (approximately 6 months) and from 13 April 2015 to 28 May 2015 (45 days). Consequently, the only stack testing to date was undertaken on January 2013, which was prior to the Tahuna WWTP upgrade in February 2013 and the full incinerator refurbishment in 2015. Accordingly, the results from January 2013 are expected to be obsolete for demonstrating current incinerator performance and were therefore not considered for this review.

2.2 Method

- Status: compliance not evaluated.
- Details: As detailed in section above, there are no stack testing results available for the current incinerator configuration, which has only been operating since November 2015.

2.3 Limits and Performance

- Status: compliance and performance not evaluated.
- Details: As detailed in section above, there are no stack testing results available for the current incinerator configuration, which has only been operating since November 2015.

3.0 COMMUNITY ODOUR SURVEY (CONDITION 6 OF CONSENT NO. RM12.139.01.V1)

3.1 Frequency

- Status: compliant.
- Details: A community odour assessment survey was carried out during November 2015 and a detailed report provided to the consent authority within the required 3 months following completion of the survey.

3.2 Method

- Status: compliant.

- Details: The survey[3] methods and design was implemented following a standard protocol that has been previously implemented at numerous locations throughout New Zealand and was approved by the Otago Regional Council. The number and location of respondents also followed consent extent requirements and recognised good practice.

3.3 Limits and Performance

- Status: not applicable.
- Details: Although there no limits set out in consent conditions for the survey results, the conclusions by Tony Dons (2015) state that "*overall there appeared to be a lesser odour impact in 2015 than in 2011 which the Dunedin City Council considers is due to the completion of the recent upgrade works*" and that "*the results show that further community odour surveys are not warranted in the foreseeable future but it is recommended that the DCC monitors odour complaint numbers and considers further odour surveys if odour complaints show a sustained increase.*" Golder has previously reviewed the survey data and report and agrees with these statements.

4.0 ODOUR COMPLAINTS REGISTER (CONDITION 8 OF CONSENT NO. RM12.139.01.V1)

4.1 Method

- Status: generally compliant, but with some inconsistencies that could be improved.
- Details: The odour complaint register generally includes the items listed in the consent condition. However, in relation to condition 8(d) – "*action taken by consent holder to remedy the situation and any policies or methods put in place to avoid or mitigate the problem occurring again*" – the comments section of the register does not always include this information. There are a number of complaint records for which odour from the Tahuna WWTP and the cause was confirmed, but which do not list actions taken to mitigate or prevent the problem. DCC have provided further information that indicates actions have been taken to this end in relation to the main causes of odour complaints. Therefore, it is considered that the intent of the condition is being complied with. It is recommended that the complaint register is modified to include this information. Additionally, the complaint register only had one column for "Date", which includes date and time, and in some cases the comments section indicates when the complaint was received at a different date and time than when the complainant noticed the odour. It is recommended that the complaint register is amended to ensure that both are recorded in line with the consent condition requirement. .

4.2 Frequency and sources of odour complaints

There no limits set out in consent conditions in terms of frequency of odour complaints. However, it is noted that these have increased in recent years, with 18 complaints recorded in 2014, 32 in 2015, and 31 in 2016 (up to May). As described above, although DCC has been taking actions to mitigate and prevent the causes of odour from the site, these are not always clearly identified or sufficiently detailed in the complaint register. Based on the complaints register and on additional information provided by DCC upon request, Golder understands the following were the main causes for odour complaints during different periods:

[3] Tony Dons 2015. Dunedin City Council Tahuna – Community Odour Survey November 2015. Prepared by Tony Dons Limited in association with Golder Associates (NZ) Limited. File DCC002. 17 December 2015.

- 2013/2014: Several odour complaints related to transportation of sludge by an open removal truck. However, only one complaint due to this source has been made since late 2014, when DCC changed to a fully enclosed system for transporting sludge to the Green Island WWTP.
- Summer 2014: Several odour complaints were received which were attributed to underperformance of the Tahuna WWTP biofilters. DCC sought expert advice and made improvements to the system, including root-raking of the biofilter media, adding 200 mm bark and installing a new irrigation system. However, these measures didn't seemed to solve the problem completely, as odour complaints due to the biofilters continued to occur, albeit with a lower frequency.
- February 2016: Several odour complaints were received which were attributed to underperformance of the Tahuna WWTP biofilters. DCC engaged Golder to carry out a detailed investigation and a number of recommendations were provided by Golder (2016) to avoid this problem in the future. Details about this investigation or about subsequent actions from DCC are not included in the complaint register, but there were no odour complaints between March to May 2016 that were attributed to the biofilters.
- April/May 2016: There have been four odour complaints in this period which seem to be due to the incinerator room. There is no information in the register about actions to mitigate this source.

5.0 SUMMARY

Overall, the Tahuna WWTP and the Musselburgh Biofilters and Generators are compliant with the consent conditions relating to its discharges to air. However, the following areas should be improved in order to demonstrate a full compliance:

- The frequency of pressure measurements of the Musselburgh biofilters has been generally weekly from 2014 onwards, but there were a few occasions when measurements did not occur for a particular week.
- The frequency of moisture measurements has been generally monthly from the second half of 2014 onwards, but were no moisture measurements for the eight months during November 2013 to June 2014, and for the month of October 2015.
- The methods for monitoring the parameters of the biofilters are not included in the monitoring records.
- The pH of the biofilters beds has not been maintained at 6 or greater, with over 50 % of measurements since June 2012 being below a pH of 6.
- The units of pressure measurements is indicated as kPa in the monitoring results spreadsheets, but as discussed they are likely to be actually in mm of water column.
- The frequency of the biosolids incinerator stack testing has not followed the consent requirements due to it not being operational for long periods of time as discussed above. However, there were two occasions when the incinerator was operational during the months of October and/or November (in 2014 and in 2015) and no stack testing was undertaken.
- The design of the odour complaint register generally includes the items required under condition 8 of Consent No. RM12.139.01.V1. However, there are a number of complaints for which odour was confirmed to be from the Tahuna WWTP, but there is no information in the register about actions taken to mitigate or prevent the odour from reoccurring (although information provided separately by DCC indicates such actions have been taken). Additionally, the date/time information in the register is not

always clear about whether they relate to when the complaint was received or when the complainant noticed the odour.

- The odour complaints due to the Tahuna WWTP have been cause for concern during certain periods, but reviewed information indicates that DCC has taken actions to mitigate and prevent these odours to the extent practicable. Information also indicates that the biofilters have historically been the key cause of odour complaints due to the Tahuna WWTP.

APPENDIX C

Consultation Letter and Flyer

DUNEDIN CITY COUNCIL
Kaunihera-a-rohe o Otepoti

50 The Octagon, PO Box 5045, Moray Place
Dunedin 9058, New Zealand
Telephone: 03 477 4000, Fax: 03 474 3488
Email: dcc@dcc.govt.nz
www.dunedin.govt.nz

04 August 2016

«AddressBlock»

«GreetingLine»

TAHUNA WASTEWATER TREATMENT PLANT PERFORMANCE REVIEW

The Dunedin City Council (DCC) holds a series of resource consents to allow the operation of the Tahuna wastewater treatment plant (WWTP). A performance review of the WWTP under those consents is now due, and the DCC would like to engage with the Liaison Group that was set up when the consent was granted.

Golder Associates (NZ) Ltd have been appointed to complete the performance review. They are preparing a report documenting the findings of their review and in particular any compliance issues, and will make recommendations for improvements to the monitoring programme including potential changes to consent conditions. The final report is due to be provided to the Otago Regional Council on 30 September, and a copy will be made available to you at this time. For your information, I have attached a summary of the findings from the monitoring data review completed to date.

I would like to invite you to share any comments, concerns or general feedback on the operation of the WWTP and its effects on your organisation. To enable inclusion and evaluation of your feedback within the report, a response by 5.00pm Friday **19 August** would be appreciated. Please be assured that we can continue to work through any issues raised beyond this timeframe. I can be contacted by email (Chelsea.McGaw@dcc.govt.nz), or by phoning 474 3314. If you would like to discuss anything or arrange to meet, please let me know.

Yours sincerely,

Chelsea McGaw
CONSENTS AND COMPLIANCE OFFICER
WATER AND WASTE SERVICE

TAHUNA WASTEWATER TREATMENT PLANT

PERFORMANCE REVIEW

Source: Dunedin City Council

Dunedin City Council is in the process of completing a performance review for the Tahuna wastewater treatment plant which is required as part of its resource consent compliance. The outcome of the performance review will be compiled into a report submitted to Otago Regional Council at the end of September 2016.

Each of the following subsections is colour coded according to whether the initial data review has shown:

A generally compliant data set (green)

Or identified some shortcomings that require further investigation (orange)

It is important to note that compliance has been determined on four levels:

- Has the monitoring that is required been completed?
- Has the frequency of monitoring met the consent requirements?
- Does the monitoring data comply with any numerical limits specified in the consent conditions?
- Have the reporting requirements been met?

Otago Regional Council regularly monitor consent compliance and provide Dunedin City Council with compliance monitoring reports. Compliance has mostly been 'Grade 1 – Compliant', although there are some specific non-compliances, discussed further below

Wastewater Flow Rates

Wastewater flows are recorded and ORC have noted that there have been exceedances of the average flow limit in some years (e.g. 10 days in the 2014-2015 year and seven days up to February in the 2015-2016 year). Further analysis of wastewater flows during wet weather needs to be completed to determine the effect of wet weather on compliance with consent limits for peak wastewater flows. Changes to improve consistency in the data reporting (instantaneous flow vs total flow in 24 hours vs average flows) in order to better determine compliance with consent limits are being considered.

Wastewater Discharge Quality

A number of wastewater discharge quality constituents have exceeded consent limits on a number of occasions (e.g., total suspended solids, oil and grease, copper, zinc). ORC graded wastewater discharge quality 'Grade 3 – non-compliant (no significant adverse effects)' in its May 2016 compliance report. Concentrations of oil and grease in the treated wastewater discharge have been regularly higher than consent limits provide for. Work is being undertaken to determine whether improvements to the treatment process are necessary or whether the current consent limit needs adjustment.

Air Quality - Odour

A community odour survey was carried out in 2015 following a best practice methodology. Odour impacts were reported to be less than those reported in 2011 which DCC attributed to the completion of upgrade works.

An odour complaints register is kept however improvements have been recommended to document the follow up actions taken by DCC to mitigate odour in response to complaints made.

It is acknowledged that there have been odour issues in the summer of 2015/16. The issue may be related to the biofilters (see below).

Air Quality – Tahuna Biofilters

DCC engaged air quality consultants in February 2016 to review and advise on the operation and performance of the biofilters. Their report confirmed that the Tahuha Biofilters were underperforming and needed some improvements which are now underway, such as replacement of the biofilters media. Although there are no specific consent conditions related to monitoring and parameters, a detailed Air Discharge Management Plan (ADMP) for these biofilters has been developed and submitted to ORC, and work is ongoing to ensure good performance and compliance with the ADMP.

Andreas Trepte, www.photo-natur.de

Air Quality – Musselburgh Biofilters

Overall the biofilters are performing well, although there have been occasions when monitoring has not been carried out at the frequency required by consent conditions and some parameters have been recorded outside expected operating ranges. Work is ongoing to ensure compliance with consent conditions.

Shellfish Surveys

Mussel flesh has been analysed for faecal coliforms and trace metals in accordance with consent requirements. There have been a number of occasions when faecal coliform numbers have exceeded the microbiological limit in the consent and ORC have been notified. On some occasions, the control site has also exceeded limits.

Whole Effluent Toxicity

The testing of whole effluent toxicity is carried out to check if the discharge may have toxic effects on marine life in the receiving environment. Although there are no numerical toxicity limits, the analyses undertaken on a range of species (marine algae, estuarine amphipod, blue mussel embryo) suggest that toxicity effects beyond the initial mixing zone are very unlikely.

Rocky Shore and Benthic Surveys

Ecological surveys of the rocky shore have been completed as required by the consent. The data collected has shown no observable adverse effects from the outfall on the rocky shore community. Subtidal benthic ecological communities have been sampled annually as required at the locations specified in the consent. The data indicates that there is no indication of any adverse effect from the outfall on the benthic invertebrate communities.

Please direct all queries and feedback to Chelsea McGaw on Chelsea.McGaw@dcc.govt.nz or 03 477 4000 by 5.00pm Friday 19 August 2016

Golder Associates

DUNEDIN CITY COUNCIL
Kaunihera a rohe o Otepoti

50 The Octagon, PO Box 5045, Moray Place
Dunedin 9058, New Zealand
Telephone: 03 477 400, Fax: 03 474 3488
Email: dcc@dcc.govt.nz
www.dunedin.govt.nz

APPENDIX D

Report Limitations

Report Limitations

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Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australia & NZ	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

AUCKLAND

Tel +64 9 486 8068
Fax +64 9 486 8072

Level 2
Nielsen Centre
129 Hurstmere Road
Takapuna
Auckland 0622

PO Box 33-849
Takapuna 0740

WELLINGTON

Tel +64 3 377 5696

Level 1
93 The Terrace
Wellington 6011

PO Box 5234
Wellington 6145

HAMILTON

Tel +64 7 859 2356
Fax +64 9 486 8072

Room 31 in the Homestead
Ruakura Research Centre
10 Bisley Road
Hamilton 3214

PO Box 19-479
Hamilton 3244

NELSON

Tel +64 3 548 1707
Fax +64 3 548 1727

Level 3
295 Trafalgar Street
Nelson 7010

PO Box 1724
Nelson 7040

CHRISTCHURCH

Tel +64 3 377 5696
Fax +64 3 377 9944

Level 1
214 Durham Street
Christchurch 8011

PO Box 2281
Christchurch 8140

DUNEDIN

Tel +64 3 479 0390
Fax +64 3 474 9642

Level 7B
John Wickliffe House
265 Princes Street
Dunedin 9016

PO Box 1087
Dunedin 9054

Golder Associates