STAFF REPORT

TO: Environment & Planning Subcommittee

FROM: Trevor James, Resource Scientist

REFERENCE: R05007

SUBJECT: **WATER QUALITY SURVEY OF FARM STREAMS IN NW GOLDEN BAY – EP05/11/08 –** Report prepared for the meeting of 16 November 2005

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1. PURPOSE OF REPORT

This report summaries the findings of recent investigations of water quality in NW Golden Bay. The full report will be available at the meeting. Helen Smale from Marlborough Shellfish Quality Programme will be in attendance to speak to the Committee.

2. INTRODUCTION

Recent studies of surface water quality in Golden Bay found several small streams and creeks to be in poor health particularly due to high concentrations of faecal bacteria, ammonia and low concentrations of dissolved oxygen. In addition, monitoring by the shellfish industry has found a high number of out of specification bacterial results for water and shellfish. This adds pressure to the western Golden Bay marine farmers as their resource and livelihood is threatened.

Faecal bacteria concentrations in the marine environment have been routinely above guidelines as identified by the aquaculture industry as part of their routine regulatory monitoring. These high bacteria concentrations affect both mussels which are grown on ropes suspended in the water column and cockle beds grown in the intertidal zone. Mussel farms at Collingwood had several significant reductions in harvest availability (72% harvestable days in 1997 reduced to 51% harvestable days in 2004); this has seriously impacted the viability of the farms. Westhaven Shellfish Ltd has also experienced a similar reduction in harvest and is facing the prospect of total closure. Ferry Point cockle fishery has been subject to an enforced closure by regulatory authorities due to faecal contamination above acceptable levels. There is no apparent trend to poorer quality but in recent years there has been increased monitoring frequency imposed in order to gain access to markets. The most significant issue is the higher concentrations of bacteria during fine periods or low rainfall events.

It is likely that cumulative effects from many discharges (even the whole Aorere catchment will affect the mussel farms whereas it is possible that more localised contamination could adversely affect the cockle beds. Sewage/septage, waterfowl, feral animals and farming are all potential contributors to this condition.

Farming can have adverse effects on human use values such as swimming, shellfish gathering as well as aquatic ecology. Dairy farming has increased potential to cause such effects due to the intensive nature of such farming. Dairy effluent has the greatest potential to effect the water quality as it contains high concentrations of disease-causing organisms and nutrients from animal faeces and urine, but can also contains other chemicals used in the cleaning of milking equipment. The major contaminants are: disease-causing organisms (faecal bacteria), organic matter, nutrients (nitrogen and phosphorus) and suspended solids. The main sources of dairy effluent are from dairy shed wash-down, feed pads/standoff pads, raceways or stock crossings.

The effects of dairy effluent on the environment vary depending on the volume and concentration of contaminants in the discharge, level of treatment and the size of the receiving environment (dilution available). The organic processes that break down dairy effluent require a lot of oxygen; when effluent is discharged to a watercourse, the dissolved oxygen concentration can be reduced to the point where fish, insects and other life in the stream suffocate. The addition of nutrients to water commonly results in rapid growth of weeds and algae, which can lead to further reduction of oxygen as the plants die and decompose. When effluent is discharged to a waterway in high enough concentrations, dissolved oxygen is removed.

Land disposal methods such as irrigation can reduce the amount of contamination discharged to surface water, but if loading rates are too high, such practices can lead to nitrate contamination of groundwater. Storage capacity is required to ensure thee is minimal discharge to water from runoff after rain.

Disease-causing organisms entering waterways from domestic sources or stock effluent or wildfowl, can make the water unsuitable for other downstream users. Polluted streams emptying into harbours and estuaries can adversely effect food-gathering sites such as shellfish beds and shellfish farms. The introduction of any human or animal waste into waterways is offensive to many New Zealanders, both Maori and Pakeha. Tangata whenua regard water as having its own mauri (life force) and this can be damaged or destroyed by pollution.

Although the amount of effluent discharged by a single dairy farm may be relatively small, the accumulative effects of many dairies contributing to one catchment can be significant. Many small waterways and drains have high ecological value, particularly coastal waterways with intact riparian grass vegetation that is used for whitebait spawning and hatching.

The aim of this study is to determine the loading of faecal bacteria discharged by selected creeks between the Aorere River and Puponga, in order to determine the specific activities on dairy farms that contribute to poor water quality. The effect of Black Swans will be assessed in future studies.

Water samples were collected for faecal coliform and *E.coli* analysis and various measurements and observations were made to determine potential or actual ecological effects of farming activities.

The following on-farm activities were assessed:

- Dairy farm effluent discharges to land and water
- Locate regular stock crossings and regularity of use
- Identify extent of build-up of effluent on raceways and assess potential for discharge to waterways
- Locate areas of significant stream bank crumbling/stock access to streams
- Locate feed pads/standoff pads and stock management practices (although these may not be in use until winter)
- Identify land drainage works, such as humping and hollowing, which may affect water quality.

This study should be regarded as a providing only an overview of factors affecting water quality in the catchment. The area of this survey includes seven dairy farms between the Aorere River, near the mouth, and Puponga. To preserve the privacy of landowners many of the sites identified in this report are not explicit. Given the resources available, it was not possible to sample every reach of every waterway in the area defined.

Fieldwork was primarily concentrated during a four week period in May 2005. Weather was unusually dry during the sampling period, but the last two sampling rounds were taken after rainfall and creek levels were elevated. Sixteen primary sites were sampled. Seven additional sites were sampled in March and April, and once after rain in May; the results from these samples are included. A total of 112 water samples were taken.

Samples of five swan faeces were collected (offshore from Unnamed Creek #2) and analysed for faecal coliforms and *E.coli* and these results are discussed.

Studies of streams or coast close to clusters of dwellings or campgrounds or municipal sewage is also being undertaken as part of compliance monitoring programmes.

3. METHODS

Most of the methodology in this study was carried out as per standard Council methods. These are described in more detail in the procedures section of the Tasman District Council Surface Water Quality Monitoring Programme document (James, 2005).

Sample Sites

Sample sites for point discharges were chosen so as to:

- ensure adequate mixing (generally around 100 metres downstream of the contaminant source, or after significant vertical and horizontal turbulence)
- minimise disturbance of sediment

- ensure adequate flow (i.e. not stagnant water)

An upstream and a downstream sample site bracketed possible sources on each farm, where feasible. Each downstream site was within the discharge plume, and each upstream site outside any area of possible downstream contamination, in order to provide a control. Exceptions were farm creeks that emerged as springs, where it was not possible to obtain an upstream site. Some farms shared a creek with at least one other farm, and sites were arrayed as a longitudinal transects following creek beds. This meant that the upstream site on one farm was treated as the downstream site on the next farm, and vice-versa.

The same sites were revisited during different weather conditions, as described below. In some cases, information came to hand after the first run that indicated the need for a change of site.

Non-point discharges were not examined in detail. This would have required setting up ‘random’ sample points, which was beyond the scope of the study.

4. RESULTS AND DISCUSSION

Laboratory results, loadings, sites that had a dissolved oxygen content of less than 80% and photographs relating to sampling done on farms and private land are presented in the full report.

When interpreting the results, it is worth noting that there was very little rain in April and, presumably, effluent would have built up in many places, rather than getting washed away by heavy rain that is so typical of the area. When it did rain (22 May and 29 May), even though total precipitation was only moderate, there may have been considerable build up of effluent to wash away.

The effect of rain was significant – at most sample sites, the concentration of Faecal coliforms and *E.coli* increase, as well as the flowrate, resulting in much higher loadings.

Farm 7: Several drains flow through low lying paddocks and converge just upstream of the floodbank and discharge through a floodgate. The flowrate is low and did not fluctuate significantly after rain. However, samples taken after rain had *E.coli* concentrations by 30-100 times higher than during dry weather, consequently increasing the loading significantly. A likely reason for this is stormwater run-off from the effluent spray irrigation and build up of pit effluent in the drain. The farmer is looking to increase buffer distances to drains from effluent irrigation area and wetlands at the junction of feeder drains and the main drain.

The standoff pad near the dairy shed has been recently concreted and will be regularly scraped and effluent bunded and used appropriately.

Farm 1: The situation on this farm is similar to that of Farm 7 except that this drain is longer and significant sources of contamination exist upstream. This site has a relatively low flowrate which increase two to seven times after rain. Samples taken after rain had *E.coli* concentrations 70-600 times higher than during dry whether, resulting in considerably higher loading. Loadings at this site were the eighth and ninth highest recorded (5^{th} highest on a farm basis). This result is not surprising given the amount of effluent that built up in the drain over time from the shed pit and stand-off pad. There have already been significant works to remedy this situation such as bunding the standoff pad and routing all effluent sources to the treatment system.

Farm 4: This farm had the greatest number of waterways passing through it and six monitoring sites were located on these waterways.

<u>Upstream</u>: This sample site is a reference site with the catchment landcover in relatively mature native bush. *E.coli* concentrations were low and even considering high flow rates, the total loading was low.

<u>Downstream</u>: This waterway had the highest flow rate of any sample site at low or high flows. This combined with moderate *E. coli* concentrations, this site had high loadings; the highest total loading of any sample site in the study. After rainfall the loadings increased 8-30 times. The source of this loading is most likely from poorly treated dairy shed effluent that is discharged to a tributary of Stream 1 particularly after rain. This is likely to be due in part to a lack of diversion of clean stormwater. This situation is being remedied.

<u>Spring Upstream</u> had very low concentration of *E.coli*, and no observable flow rate even after rainfall, which means loadings could not be calculated. Water may flow in this drain when the Stream 13 is in high flow.

<u>Spring downstream</u> showed highly variable and some high concentrations of *E. coli*, suggesting that one of drains that enters this drainage downstream of the spring contains faecal contamination.

<u>Stock Crossing Upstream</u>: This tidal arm of the estuary was used as a stream crossing under the main road for most of the milking season but was not used after 2 May. A second crossing is located just downstream of the driveway prior to 2 May and over the bridge of the driveway after this date. Although *E. coli* concentration was relatively high, this site had very low flow and thus total loading was relatively low. Very high levels of fine sediment were found in the bed here. There is no intention of using this crossing again.

<u>Stock Crossing Downstream</u>. Before the rain, this site had moderate *E. coli* concentration and moderate flow, resulting in moderate total loading. The concentration was often lower downstream of the crossing (for samples collected on the same day) which could be due to dilution and tidal cleansing over the sampling period as this crossing was not be used over the sampling period. The high loadings for samples taken at high flows could be due to effluent running off races on the approaches to the race. A contractor has been engaged to deal with this issue.

Farm 2:

Stream 2 Upstream: This site is adjacent to paddock on one side but vegetated along both banks. *E. coli* concentrations were typically low (except on 23 May at high flow) and flow rates are relatively low, resulting in low loadings.

Stream 2 Midstream. This site is adjacent to, and in between the milking shed and the effluent pond, just downstream of the standoff pad. Typically moderate *E. coli*, but exceptionally high on 29 May at high flow. Relatively high flow rates result in high loading (3rd highest recorded). Faecal bacteria are likely to be attenuated due to flow through a wetland and into groundwater before it reaches the floodgate.

Stream 2 Downstream floodgate: Typically only moderate *E. coli* concentration and, in low flow condition, results in low loading. However, on 29 May when *E. coli* was elevated and flow rate was high there was a very high loading (fifth highest result) discharged to the estuary. This is likely to be caused by the standoff pad and effluent pond discharge as picked up on 29 May. Plans are underway to deal with this situation.

Farm 6:
Spring: Consistently high or very high *E. coli* concentrations were found at this site. However, there was usually immeasurable flow, thus loading is small. This spring could only be faecal contamination could be from individual faecal pellets from birds or farm animals which is considered minor. Cows were in the affected paddock from 20-25 May and not before – this does not explain the high result on 17 May. This water was dammed 200 metres downstream of spring and used for irrigation so no water would have discharged to the waterway downstream (upstream of Farm 3).

No consistent correlation was found between the results for the site upstream Farm 3 with that downstream. Potential causes include: soil from land development carried out over the period of sampling or faecal deposits from birds (there is a significant pukeko roast very close to the creek).

Relative to other loadings found in this survey loading from the downstream site is low.

Farm 3:
Upstream. This site has relatively high *E. coli* concentration, but relatively low flow rates and ultimately moderate loading.

Downstream (Stream 11) showed variable, but relatively high *E. coli* loading and moderate flow rates, ultimately high loading. The source is likely to be from an upstream landowner.

Farm 5:
Stream 3 North had relatively high *E.coli* concentration, but with a very low flow rate even after rainfall, a low loading resulted. Stream 3 South had low *E. coli* concentration and low flow rate resulting in low loading as above.

Marble Creek: Relatively low concentrations of *E.coli* were recorded in Marble Creek and not much variation over different flows. The average concentration in this creek was higher than the reference site on Stream 1 which had similar flows (median of 45 versus a median of 7.5 respectively). A relatively low concentration was recorded after rainfall events but due to the high flow a moderate loading resulted.

Stream 6: Moderate loadings were found from this creek probably as a result of dry stock being fenced in close to the creek. This issue has been communicated with the landowner and a plan has been agreed upon.

Stream 12: Low to moderate concentrations of *E.coli* were found from this estuary. Due to high flow rates this resulted in a high loading on one occasion after rainfall (fourth highest result). This could be due to unfenced riparian zones on a dry-stock farm that was not investigated as part of this study.

Stream 7: Low to moderate loadings were found in this waterway except after high flow when there was a high loading (seventh highest result). This creek drains dry stock farmland and no specific faecal contamination sources are currently known.

Stream 5: Low loadings were found in this creek. However, the *E.coli* concentration was well above stock drinking water guidelines (ANZECC 1993) on one occasion during dry weather.

Unnamed Creek #2: High *E.coli* concentrations were found in this waterway but due to the very low flow rate in low rainfall periods there was a low loading. A moderate loading was recorded at high flow, however this loading was lower than the Marble Creek reference site.

Faecal Bacteria Output from Black Swans

Black Swan numbers are known to range from 6,000 to 14,000 in the coastal waters of Golden Bay, where they feed on eel grass (see Appendix III). Black Swans have been estimated to excrete 10^8 to 10^9 faecal coliforms per day (Sinton, L; ESR, Christchurch, *pers.comm*.).

The total loading from 10,000 swans equates then to 10^{12} to 10^{13} faecal coliforms per day.

The *E. coli* concentration in the five samples of Swan faeces taken as part of this study was highly variable and ranged from <2000 to 20,000,000 cfu/100g (wet weight).

Black Swan versus Dairy Cow Intake and Faecal Outputs

It has been estimated that 86 Black Swans would deposit an equivalent amount of faecal material as one dairy cow on a daily basis (Allen, J AGFIRST & Dexcel – website). This would equate to 105 dairy cows living in the whole of Farewell Spit/Puponga area, based on the 2005 trend count of 9100 Black Swans.

However, Black Swan food near Puponga, maybe nutritionally different to those figures presented above, which were feeding in a freshwater environment (Murray Williams (DoC), *Pers. omm.*). Therefore it is estimated 61.8 swans would deposit an equivalent amount of faecal material as one dairy cow (4.5kg/0.072kg). This would equate to 147 dairy cows living in the whole of Farewell Spit/Puponga area, based on the 2005 trend count of 9100 Black Swans. These figures were based on faecal excretion rates for Mute Swans with a correction factor for body size. It has been found that Swans have a very different rate than Canada Geese for example (Davey, L *pers omm.*).

According to E. Geldrich, 1966, cows have half the loading compared to ducks (5,428 million/day compared to 11 million/day.

Attenuation of Black Swan Faecal Pellets

From limited observations made during this study, it appears that swan faeces dissolve completely in seawater during one tide cycle. No faecal pellets remain intact once the tide has been over them. In clear, saline water, coliform die-off is two-three orders of magnitude per day. Dilution is expected to be significant. It is not known how such attenuation and dispersion compares to that from dairy farm sources.

Swan density is greatest towards Puponga (McDonald, AJ, *pers omm.*. And from observations). The tidal flats are much more extensive near Puponga than at Pakawau and there is a greater extent of eel grass available in this area for swans to forage.

Murphy et al. (2005) provide evidence that duck faeces are a potential human health hazard, and identified bacteria potentially useful for differentiating duck faeces from other faecal sources. One could expect swan faeces to be a human health hazard, and that bacterial analysis could differentiate swan faeces from other faecal sources.

Black Swan Faecal Pellets

Ecological Effects of Black Swans
Sagar (1995) suggested that there is not an over-grazing problem in the Farewell Spit area, although there may be local sites where this does occur. In areas of Black Swan feeding invertebrate diversity was

During the period of investigation all water and shellfish flesh samples at the mussel farms were within guidelines for faecal coliform concentration. These guidelines are 14 and 230 faecal coliforms/100ml respectively. No information is available for water or shellfish quality from the cockle beds.

5. CONCLUSION

This study identified a number of waterways on farms that contribute moderate loadings to the near-shore marine environment. The highest loadings were these from stream 1 (three-four times the next highest loading to the marine environment). During wet weather these loadings increased dramatically in some farm drains (particularly farm 1 and 7 where there was up to 30-600 times the dry weather loading). However, loadings in three waterways did not increase significantly after wet weather.

The loading from the two reference sites was very different. Marble Creek for instance recorded a moderately high result after rain whereas Gorge Creek showed consistently low loadings. It is possible that a minor source of contamination exists in Marble Creek.

It is unknown how dilution and dispersion mechanisms with the tide would affect the delivery of contaminants to the shellfish farms. Some obvious sources of faecal contamination were identified as a result of this study.

There are many remedial actions that have recently been completed or planned to be completed as soon as possible but certainly within the next six months. These should be enough to show a significant improvement in water quality from these streams. Continued discharge of significant amounts of effluent beyond the agreed timeframes will not be tolerated.

6. RECOMMENDATION

That this report be received.

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