Oamaru Bay Coastal Land Disposal – A Retrospective

Clive Rowe[A,B], Karen Sky[A]

[A]Pattle Delamore Partners Ltd, PO Box 9528, Auckland 1149
[B]Corresponding author. Email: clive.rowe@pdp.co.nz

ABSTRACT

Oamaru Bay is a small beach community on the western coast of the Coromandel Peninsular. Its winter and peak summer populations are about 70 and 400 respectively. Its wastewater has been disposed of to land since a reticulated sewerage scheme was installed in 1992. Disposal is by subsurface irrigation in an area of riparian pasture land that is about one metre above and 100 metres inshore of the high tide mark.

The system's performance in terms of its effects on the receiving environment were investigated in some depth in 2007/2008. This paper describes both the engineering of the original scheme and the recent environmental effect investigations.

Keywords: Appropriate technology; subsurface irrigation; onsite disposal; coastal; foreshore.

INTRODUCTION

Oamaru Bay is a small community on the western, Hauraki Gulf side of the Coromandel peninsula, about 7km north of Coromandel township. It consists of about 25 dwellings, of which considerably more than half are holiday homes that are unoccupied for most of the year. There is also a holiday park with cabins and facilities for campers and caravans, and a public toilet at the beach. Until 1992, each property in the bay had its own onsite sanitation system, consisting variously of septic tanks and basic pit toilets.

Normal resident and peak holiday-season populations are about 70 and 400 respectively.

Off-season, summer peak and annual average flows are in the order of 10, 50 and 15 cubic metres per day respectively.

THE ENVIRONMENT

The beach at Oamaru Bay is very popular and much-used for swimming. If any sewage or effluent that should overflow or seep through the ground, it would have only a short distance and time of travel to the water's edge.

On the other hand, there are several hectares of flat alluvial pasture land behind the beach in Koputauaki Bay, with the nearest of the few houses there being at least 500 metres inland from the shore line.

The topographic and surface geologies of the two bays are also quite different, as is evident in Fig. 1 which also shows the markedly different areas of foreshore that are exposed at low tide.

Figure 1. Site location.

THE NEW SEWERAGE SYSTEM

In the system that was commissioned in 1992, raw sewage from each property discharges initially into a septic tank, so that the reticulation system carries only effluent from those tanks, and no gross solids. Properties along the beach-front are served in pairs, with neighbouring houses discharging into shared septic tanks that are constructed in the roadside verge, more or less on the line of their common side boundaries.

Collected effluent is pumped over the hill to Koputauaki Bay, where the arriving effluent is first delivered into a tank that is fitted with an automatic dosing siphon, and the siphon then discharges large intermittent pulses of effluent into the subsurface irrigation disposal system.

The entire system, from collection to final disposal in the irrigation field, is designed to involve as little machinery and dependence on human attendance as possible, without sacrificing operational or environmental efficiency.

PRE-DESIGN INVESTIGATIONS

The disposal scheme adopted was one of three investigated. One of the other two involved irrigation of the hill country behind the beach, which the holiday park proprietors owned. The third involved direct outfall discharge to the sea.

Assessment of the marine discharge option, included investigating the feasibility of UV disinfection of the septic tank effluent. This involved investigating the feasibility of clarifying septic tank effluent sufficiently for the UV to be effective. Notwithstanding positive results of that investigation, the marine discharge option lost out to the adopted scheme on environmental, cultural and cost grounds.

Cost and cultural factors, plus the need for significant operation and maintenance attendance, led to the hill country irrigation option also failing to match the adopted scheme.

The adopted scheme of subsurface irrigated disposal in Koputauaki Bay was also subject to thorough pre-design determination of soil permeability and water table profile, including numerous field percolation tests and laboratory analyses of soil particle size distributions.

KEY FEATURES OF THE IRRIGATION SYSTEM

Effluent is applied to the irrigation field in intermittent, pulsed doses, in accordance with recognised good practice (EPA). This intermittent dosing regime was provided by the siphon dose tank already mentioned.

Efficiency of transfer of effluent from any subsurface irrigation distribution system into the receiving soil is maximised by having:

- The maximum possible area of receiving soil interface, to minimise the interface application rate.
- The minimum possible volume of detention in the system of conduits (and voids in any gravel backfilling) that distribute the effluent around the irrigation system and to the infiltrative surfaces of the receiving soils.

Both of these objectives were achieved in the adopted scheme by deviating from the traditional pipe-in-gravel form of distribution/discharge line.

The conduit in this scheme is instead of a proprietary, sleeved waffle form, installed in a narrow slit-trench. Backfilled with the sandy material excavated in the cutting of the trench, the sleeved waffle effectively became a 40mm wide x 500mm high “tunnel” through native soil.

Avoiding the use of the normal gravel backfill had the particular benefit of eliminating the significant volume of voids between its relatively coarse particles. This elimination of the gravel and its voids greatly enhanced the efficiency of hydraulic and dosing performance able to be incorporated in the distribution system design.

Other salient design features of the irrigation system included:

Site ground level:	Between 2.3 and 2.8 metres above MSL
Net area of irrigation field:	0.625 hectare
Total length of irrigation lines:	1650 metres
Spacing of irrigation lines:	4.0 metres centre to centre
Volume of each discharge from dosing siphon:	30 cubic metres
Permeability of (silty sand) receiving soil:	$1x10^{-6}$ metres per second

PERFORMANCE 17 YEARS ON

General

With the original discharge permit for the irrigation disposal system expiring, investigation of the system’s performance was required to support the application for a new consent. Those investigations were carried out in 2008, by which time the system had been operating for some 17 years.

These new investigations commenced with a site visit on 4 January 2008, at the end of the peak 2007/2008 summer holiday period when, with the beach having been populated at its annual peak less than a week previously, mounding of groundwater beneath the irrigation

field would have been close to if not actually at its annual maximum on the 4 January date of the inspection.

Notwithstanding that worst case scenario, there was no evidence of any groundwater near the ground surface. Indeed, the surface of soil at both the irrigation site and the adjacent salt marsh (covered by the sea during high spring tides) was parched and extensively crazed by shrinkage cracks.

That broad overview phase of investigation was followed later in the year by specialist studies of:

- The behaviour of the groundwater beneath and around the irrigation field,
- The chemical and microbiological quality of that underlying groundwater and
- Ecological effects on macrofauna in the foreshore area, via which groundwater from beneath the irrigation area entered the local marine environment.

The last two of these three specialist investigations also involved collection and analysis of samples from control sites, remote from the effects of the irrigation field. Sampling and monitoring locations for all of these second-phase investigations are shown in Figure 2 below.

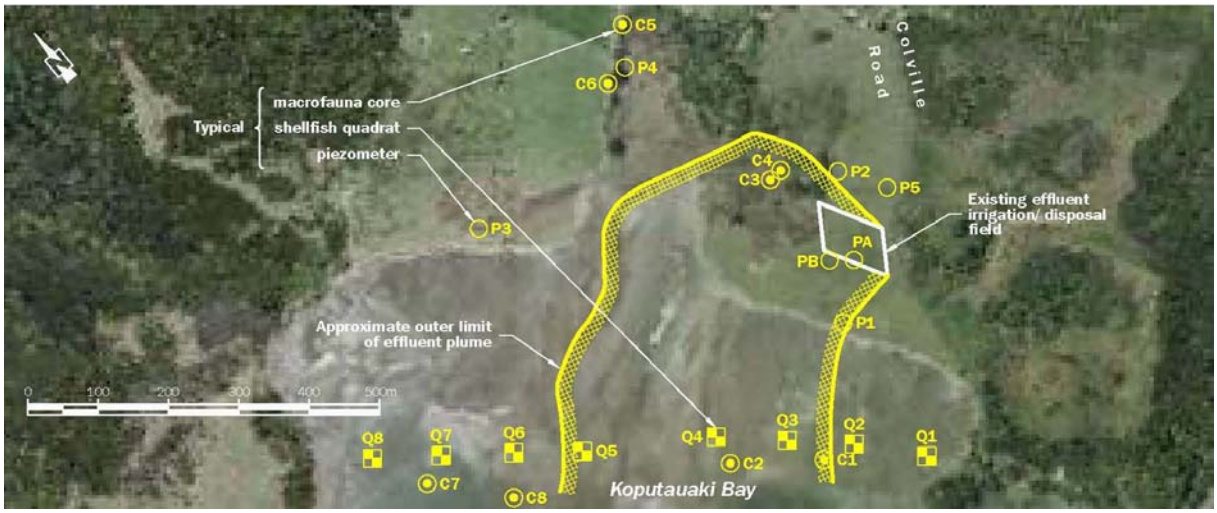

Figure 2. Sampling and monitoring locations.

Groundwater

The groundwater investigation involved:

- Installation, monitoring of water levels in, and the collection and chemical and microbiological analysis of groundwater samples from piezometers, in August 2008,
- Computer modelling of water-table mounding and groundwater flow beneath and away from the irrigated area, using data collected and derived from the piezometers and from original pre-design investigations of 1990-1991.

The computer modelling indicated groundwater times of travel, to the high tide and mean sea level lines in Koputauaki Bay, of 700 and 1400 days respectively.

The extent of the effluent plume in the groundwater flow, and the location of the irrigation field itself, are indicated in Figure 2.

Results of chemical analyses were assessed against various aquatic guideline limits published by central government agencies in Australasia (ANZECC, MfE).

Samples from all piezometers returned levels of total nitrogen (TN) above the freshwater guideline value of 0.614 g/m^3. Additionally, the samples from three piezometers had levels of faecal coliforms (FC) at or above the recreational shellfish gathering guideline of 14 MPN/100ml. Levels of nitrate and total oxidized nitrogen (TON) in samples collected from groundwater directly below the actual irrigation field also exceeded relevant freshwater guidelines.

It is important to note that these exceedences are not entirely valid because, firstly, the samples are of groundwater whereas the guidelines relate to surface waters and, secondly, the groundwater will mix with and be diluted by seawater as it emerges from the foreshore and seabed. The mixing and dilution relevant to this case is discussed in the following passages.

Groundwater emerging from a beach such as this does so seawards of the mean sea level, or "half-tide" line. The two tides that occur each day will flush this area of foreshore with about 200,000 cubic metres of seawater every 24 hours, equating to a tidal flushing dilution of about 10,000 :1. Adjusted for this dilution, the worst case sample results become as follows:

- The worst case TN result equates to a diluted concentration of 0.0038 g/m3, well below the marine guideline of 0.12 g/m3 and
- The worst case TON result equates to a diluted concentration of 0.00092 g/m3, also well below that parameter's marine guideline value of 0.005 g/m3,

indicating that the discharged effluent is unlikely to have any more than minor adverse effect on either the estuary or beach environments.

The results also indicate that droppings from cattle on the property, which are able to range freely of their pasture onto the beach area, are likely to be contributing significantly to TN and FC in the groundwater.

Benthic Macrofauna

Potential effects on the populations of benthic macrofauna in the Kapuauaki Bay foreshore area were investigated in two stages:

- An initial coarse survey of shellfish, to determine whether or not there was any gross indication of pollution and
- Following negative findings from that preliminary survey, a second more detailed assessment of the benthic macroinvertebrate community composition.

Sampling locations for both the initial and second benthic surveys are shown in Figure 2.

The first, preliminary survey was carried out in August 2008. It involved the sampling of eight 0.1 square metre quadrats at approximately 100 metre intervals, four along each of the southern and northern ends of the beach. All eight sampling sites were located near the low tide line of the beach, in the zone where groundwater was visibly emerging from the beach at low tide, and were excavated by hand, when the tide was out.

All live individual shellfish over 5mm in size were collected, identified and measured, and the sizes and numbers of species and individuals found in each quadrat were recorded.

Generally, more individuals were noted on the southern part of the beach, and there were also higher numbers of species recorded in the quadrats in that area. Species composition differed across the beach, southern quadrats being dominated by cockles, whelks and nut shells, and the northern quadrats containing mainly pipi and nut shells. Pipi were only found in the northern quadrats. The shellfish over 26mm in size that were recorded from the southern end of the beach were all whelks and barnacles, while at the northern end of the beach several large (>40mm) pipi were recorded.

The habitat was non-uniform along the length of the beach and at the quadrats. It varied from coarse sand at some locations, to rocky at others, and fine silty sand at yet others. It was therefore not surprising that quite different populations were encountered in the different quadrats.

A diverse population of shellfish appeared to exist in the southern area of the beach adjacent to the wastewater disposal field. While no pipi were found in that area, the four quadrats sampled were considered too small in number to warrant the drawing of any firm conclusions from the counts found.

The second more detailed investigation began with the collection, later the same month, of fresh samples of the foreshore sediments. Samples were collected using a 150mm diameter corer, to a depth of 100mm. One pair of samples was collected from the northern end of the beach near the low tide level, a second pair from the northern side of the estuary, outside the effluent/groundwater plume, a third pair from the potentially affected southern end of the beach near the low tide level, and a fourth pair from the southern side of the estuary, within the effluent plume corridor.

The collected core-samples were analysed for benthic macrofauna by a taxonomist.

Species diversity was slightly higher in the cores collected from the southern side of the beach (both with eight different taxa identified), compared with the northern beach cores (with six and five different taxa respectively). In freshwater, gastropods are known to be pollution-tolerant, but less is known of the tolerance of macroinvertebrates in coastal environments in New Zealand.

Overall, fourteen different taxa were recorded from the cores at the southern end of the beach, compared with nine in the cores at the northern end. Higher numbers of individuals were recorded from the cores taken on the northern side of the beach, largely due to the high number of Aonides polychaetes (n=68) and the mollusc Paphies australis (n=25). Aonides are generally regarded as preferring wave-exposed sandy substrate over mud, and the presence of high numbers in the northern beach area could be indicative of those conditions. High counts of Paphies spp. have also been correlated with high energy environments (ARC).

Lower species diversity was found in the estuarine reach of the stream, with just three different taxa identified from the two cores on the southern (potentially impacted) side and two taxa on the northern (control) side.

While the effects of pollution on benthic communities may be subtle and not detectable from a single sampling exercise such as this, there was no indication from the results that the communities sampled were under any environmental stress from effluent discharged in the adjacent irrigation disposal field.

CONCLUSIONS

While concentrations of some constituents in the effluent-affected groundwater exceeded guideline values, cattle grazing on the site were considered to be contributing significantly to this. Moreover, it is surface water and not groundwater that the only available guideline values relate to, and the groundwater is subject to mixing with and dilution by the seawater that flushes the beach twice each day.

Nutrient concentrations found in the zone of flow of effluent-affected groundwater were considered unlikely to be having any adverse effect on either of the tidal inlet or beach environments.

Similarly, the slightly elevated levels of faecal coliforms detected in groundwater at the site were considered unlikely to indicate exceedences of bacteriological guideline values for shellfish-gathering, in the receiving beach or estuary environments (MfE).

Generally the communities of shellfish and other benthic macrofauna found on the southern end of the beach were more diverse in terms of species richness than those encountered on the northern end of the beach. Within the tidal inlet, similar fauna were encountered on both the northern (reference/control) and southern (potentially impacted) sides.

Overall, based on the results obtained, there was no indication that environmental effects of the irrigated disposal of effluent were any more than minor.

The existing system of subsurface irrigated disposal of effluent was therefore judged to be performing perfectly adequately, as the original design intended.

The consent was duly renewed, based on the investigations and conclusions discussed above.

POSTSCRIPT

Notwithstanding the finding of satisfactory performance, the 2008 investigations also concluded that the performance could be improved even further by relatively inexpensive upgrading measures involving technologies that had emerged since the original design was developed in 1990-1991. Such measures included:

- The retrofitting of filter screens on the outlets of all septic tanks,
- Construction of a “Landcare” denitrification bed (Schipper & Cameron) around the down-gradient perimeter of the irrigation/disposal field
- Planting of that down-slope perimeter in phreatophytic trees and shrubs, to draw water and nutrients from the flow of groundwater/effluent that passes through their root zone, thereby reducing the amounts discharging to the ultimate marine receiving environment.

Consideration of these improvements was deferred and, at the time of writing, no decisions on their implementation or otherwise had been made

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the WT Nichols Family Trust and the Thames-Coromandel District Council for their respective permissions to publish this paper. Bioresearches Limited are also thanked for their provision of the taxonomic analysis.

REFERENCES

ANZECC, Australian and New Zealand Guidelines for Fresh and Marine Water Quality; Australian and New Zealand Environment and Conservation Council, jointly with Agricultural & Resource Management Council of Australia & NZ 2000.

ARC, Ecological Monitoring of the Okura Estuary Report 4: Final Report of the Year2002-2004; Auckland Regional Council, Technical Publication 216; 2003.

EPA, Design Manual,Onsite Wastewater Treatment & Disposal systems; USEPA, Oct 1980.

MfE, Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas; (NZ) Ministry for the Environment; (updated) 2003.

PDP, Literature Review on Viruses from Sewage & their Transport Groundwater; Pattle Delamore Partners Ltd (for Canterbury Regional Council); Nov 1999.

Schipper L & Cameron S, Denitrification Beds: final nitrogen removal from wastewater; *Water and Wastes in New Zealand*; Issue 137, Nov 2004, p28.