Ahuriri Estuary:

Contact Recreation and Food Gathering Review

July 2014

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Environmental Science - Water Quality and Ecology

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Contents

Tables

Figures

Executive summary

The Ahuriri Estuary, Napier is a significant ecological and recreational resource for the Hawke's Bay community. It is recognised as a nationally significant wildlife and fisheries habitat, and a nationally important example of tectonic processes. Natural and human-induced changes to the estuary over the last century have considerably changed the estuary form.

As one of the few sheltered, tidal lagoon estuaries within Hawke's Bay, Pandora Pond provides for a number of recreational opportunities including swimming, kayaking, sailing, and waka ama. These activities can however be compromised by the presence of faecal contaminants that have the potential to cause illness. Faecal indicator organisms sampled within the Ahuriri Estuary may stem from stormwater, overland flow or accidental sewage discharges.

The estuary is currently classified as being in 'fair' condition in terms of contact recreation, because it is influenced by inflows with elevated bacterial concentrations – these may increase the risk of illness to recreational users of the estuary. Other metrics, such as clarity and algal growth do not indicate impairment of recreational opportunities as a consequence of nuisance algal growths.

The Ahuriri Estuary also provides food gathering opportunities, most commonly for the cockle (*Austrovenus stutchburyi)* and various species of flounder. Current information suggests that shellfish gathered from the estuary may be unsuitable for human consumption because of elevated faecal indicator bacteria concentrations. While there is some debate regarding the confidence in current guidelines for bacterial concentrations in foods harvested recreationally for human consumption, the inflow of stormwater derived from urban drains and proximity of shellfish beds to these inflows indicate that the estuary should not be regarded as safe food-source.

If the community regards the water and sediment quality within the estuary as impaired for contact recreation and food-gathering purposes, techniques such faecal source tracking may assist in identifying the sources of faecal contamination in targeting appropriate management strategies.

Toxic metal contamination of shellfish and fish species is currently not at levels expected to pose immediate health risks. Although it was not within the scope of this study to assess the indirect effects of contaminants on the abundance and distribution of edible resources, this was identified as an area for further investigation.

1 Introduction

As they form the interface between land and sea, estuarine habitats are unique, distinctive and dynamic environments. They experience rapid chemical and physical changes over tidal cycles, yet provide some of the most important and diverse habitats supporting bird roosting, feeding and breeding, fish spawning and nursery grounds, and ecological services that help to sustain environmental quality and integrity. They are productive habitats, and play an important role in water regulation and nutrient cycling.

In a region dominated by alluvial flood plain river mouths, the Ahuriri Estuary (Te Whanganui-a-Orotu) represents one of the few tidal lagoon estuaries in Hawke's Bay. Formed in the wake of the 1931 earthquake, the Ahuriri Estuary is the remnants of the former Ahuriri Lagoon (Figure 1-1). The earthquake resulted in an uplift of between 1 - 2 metres, exposing approximately 1300 ha (Figure 1-2) (Chague-Goff et al., 2000). Drainage and reclamation following the earthquake has reduced the area to its current size of approximately 470 ha of true estuary, and around 175 ha of associated wetlands (Figure 1-3; (Comerty, 1996).

Figure 1-1: Ahuriri Lagoon pre-1931 earthquake. Source: Hawke's Bay Museum.

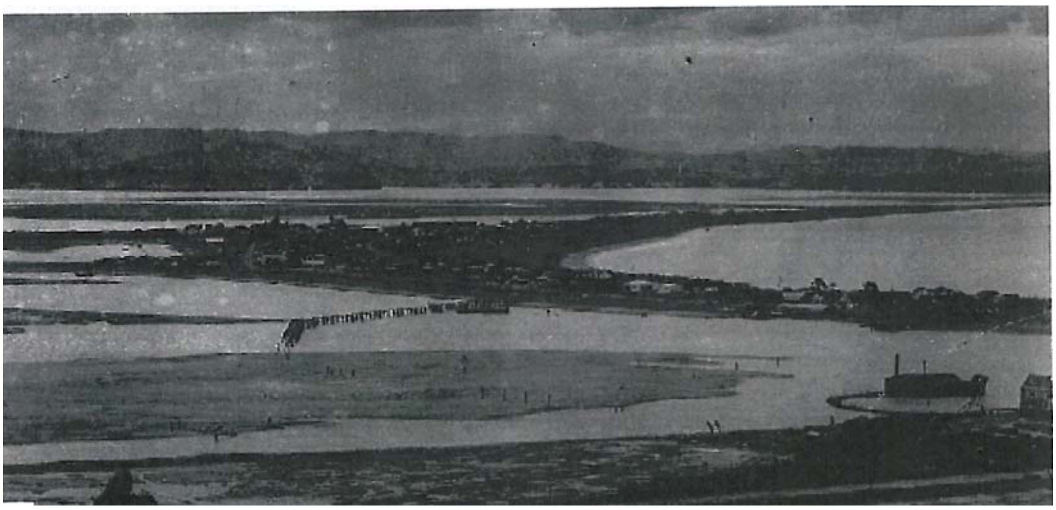

Figure 1-2: Ahuriri Lagoon post-1931 earthquake. Source: Hawke's Bay Museum.

Despite extensive modification, reclamation, drainage and discharges, the estuary is recognised as an area of regional and national significance, with high wildlife and fisheries values. The estuary provides important feeding area for 20 species of trans-equatorial migrants (waders and terns), six Australian species (herons, ibises and duck), and a number of native species including white heron and royal spoonbill (Knox, 1979). Additionally, the estuary makes a significant contribution to Hawke's Bay marine fisheries, supporting approximately 29 species of fish during some stage of their life cycle. Some species (e.g. kahawai, grey mullet, yellow-bellied flounder, stargazer and parore) use the area for feeding, and around 11 species use the area as a nursery or spawning ground. These include commercially important species such as yellow-bellied flounder, grey mullet, sand flounder, common sole, and yellow-eyed mullet (Kilner and Akroyd, 1978).

Figure 1-3: Drainage channels constructed to the north and south of the main estuary outfall channel to develop agricultural land. Source: Hawke's Bay Museum.

Ahuriri Estuary is listed as a Significant Conservation Area under the Regional Coastal Environment Plan (HBRC, 2012), a Wetland of Ecological and Representative Importance (WERI), and a Site of Special Wildlife Interest (SSWI) (Henriques, 1990). A Wildlife Refuge status protects the areas between the Southern Marsh, Westshore Lagoon and the estuary, from the low level bridge to Pandora Pond.

Figure 1-4: Ahuriri Estuary, Napier 2006.

2 Methods for assessing contact recreation and food gathering risk

2.1 Contact recreation

"Contact recreation" includes any activity that causes people come into contact with water where a reasonable risk of inhaling or ingesting water exists. At times, the suitability of water for recreation may be compromised by the presence of human or animal faecal material resulting from land run-off, discharges or from natural populations of animals or birds. During these events, water may contain pathogens from this faecal matter. The risk of contracting illnesses such as gastro-enteritis, respiratory illnesses, Hepatitis A, giardiasis, cryptosporidiosis, campylobacterosis, and salmonellosis increases as the risk of exposure to pathogenic organism increases (MfE and MoH, 2003).

From an aesthetic point of view, water clarity can be an important consideration for people undertaking recreational activities. Although not as important in marine waters which tend to be naturally more turbid, freshwater recreation choice can be influenced by visual clarity.

Visual clarity (determined by black disk visibility), is not generally measured in marine or estuarine waters. Turbidity, a measure of the amount of light scattered or absorbed by particles in the water, is more commonly used in New Zealand coastal water quality monitoring programmes. An inverse relationship can generally be demonstrated between turbidity and visual clarity. Generally, if turbidity meets the requirements for aquatic ecosystems, it is likely to meet the aesthetic value for contact recreation as well.

High algal biomass can influence aesthetic values associated with contact recreation. High algal biomass may reduce the visual clarity of the water by making it more turbid, or by changing the colour of the water, creating 'murky' or discoloured water. Human health risk associated with contact recreation may be increased if toxic species are present. Increased nutrient inputs from either land or marine sources can influence (increase) algal biomass growth rates.

Current guidelines for the attributes associated with contact recreation are detailed in Table 2-1.

Table 2-1: Current water quality guidelines associated with contact recreation. cfu = colony forming units, NTU = Nephelometric turbidity units, BD = black disk.

Attribute	Guideline value[1]		Source	Value
	Satisfactory	Unsatisfactory/ Unacceptable		
Enterococci (cfu/100 mL)	<280 cfu/100 mL	>280 cfu/100 mL	(MfE and MoH, 2003)	Human health
Turbidity (NTU)	0.5-10 NTU	>10 NTU	(ANZECC, 2000)	Aquatic ecosystems
Visual clarity (BD)	>1.6 m	<1.6 m	(MfE, 1994)	Aesthetic and safety
Chlorophyll *a* (g/m^3)	<4 µg/L	>4 µg/L	(ANZECC, 2000)1	Aquatic ecosystems
Toxic algal species (cells/mL)	Absent	Present	-	Human health and aquatic ecosystems

[1]These guidelines refer to ANZECC 2000 for South-Eastern Australia which is used in the absence of New Zealand specific estuarine guidance.

2.2 Food gathering

With the exception of overlying water quality, comparatively little information or guidance exists around the risk associated with recreational harvesting of shellfish and fish. Export food safety guidelines are applied in the absence of recreational specific guidelines; however it is acknowledged that this appears to be an area for further work or development.

For shellfish gathering the attributes likely to compromise the ability to collect shellfish include contamination by faecal material that may contain pathogens. Additionally, the ability of shellfish and fish to accumulate contaminants such as trace metals and other industrial and stormwater related toxins, means that these parameters are also used to assess risks associated with food gathering.

Current guidelines for the attributes associated with shellfish/fish gathering are detailed in Table 2-2.

Table 2-2: Current guideline values associated with water and shellfish quality. MPN = Most Probable Number.

Attribute	Guideline		Source	Relevance
	Satisfactory	Unsatisfactory/ Unacceptable		
Faecal coliforms in overlying waters	Seasonal median ≤ 14 MPN/100mL ≤ 10% of samples ≤ 43MPN/100mL	Seasonal median > 14 MPN/100mL > 10% of samples > 43MPN/100mL	(MfE and MoH, 2003)	Human Health
Toxic algal species in overlying waters	Not present	Present	Nil	Human Health and Aquatic Ecosystems
E. coli in shellfish flesh	Median ≤ 230 MPN/100g and ≤ 10% of samples ≤ 700 MPN/100g	Median > 230 MPN/100g and > 10% of samples > 700 MPN/100g	(NZFSA, 1995)	Human Health
Trace metals	Below FSA guidelines	Above FSA guidelines		Human Health

3 Contact recreation

Like many Hawke's Bay rivers and lagoons, the Pandora Pond (or Humber Street Pond) within the Ahuriri Estuary provides recreational opportunities, including swimming, kayaking, sailing, and waka ama. This is perhaps one of the highest profile uses of the estuary, along with birdwatching, and its accessibility makes recreation a dominant use and value for the estuary.

The Pandora Pond was created when sediment was excavated in 1977 to provide fill for the cargo handling area in the Port of Napier (Lee, 1977). This created a pond that provided Napier residents with an easily accessible, enclosed area for recreational and boating activities suitable for families. On an exposed coastline such as Hawke's Bay, this area provides important opportunities for aquatic recreation.

3.1 Background

Use of an area for contact recreation can be driven by a number of external factors such as climate, proximity from home and the physical characteristics of the recreational site (Madarasz-Smith, 2010). Increasingly water quality is becoming a prevalent deciding factor in people's choice of recreational areas. The key attributes that may affect water quality, and therefore affect people's recreational experience, include the risk of illness from faecal contamination (bacteria and pathogens), water clarity, the extent of algal coverage and the general amenity value or mauri of the area. This report focusses on the first three key attributes - while recognising that general amenity or mauri is important, it falls outside the scope of this report.

3.2 Threats

Faecal material can enter water via stormwater, overland flow or accidental sewage discharges. Within the Ahuriri estuary, faecal contamination has been demonstrated to have resulted from all of the above at various times. Farming within the upper catchment can contribute bacteria by overland flow during periods of rain and stock watering, stormwater and land drainage discharges occur regularly throughout the middle and lower estuary (Rycroft, 2000), and accidental sewerage discharges have occurred infrequently in the past. While sewerage discharges are more likely to cause high concentration of potentially pathogenic organisms and immediate health risks, these tend to be short-lived and well communicated. The overall risk to public health associated with sewer overflows may be therefore be lower than the risks associated with less obvious but more frequent inputs such as diffuse runoff from agricultural lands and stormwater.

Several studies have identified variable and at times poor water quality within the Ahuriri Estuary. In general high numbers of bacteria were found in upstream reaches of the estuary and in drains, most likely due to lower levels of dilution by seawater (Hooper, 1989), or following periods of heavy rain (Fenton, 1997). In the lower estuary, water entering the estuary may contain high concentrations of faecal bacteria at times (e.g. Tyne Street Drain (30-2000 FC/100 mL (Hooper, 1989) where FC = faecal coliforms).

3.3 Current state

3.3.1 Faecal bacteria

National guidelines identify concentrations at which the risk of illness associated with contact recreation is no longer considered acceptable (MfE and MoH, 2003). This allows the public to be informed of the health risks, and make informed decisions regarding their exposure to these risks (see Appendix A for an explanation of these guidelines).

The results of routine sampling at the Pandora Pond, the most popular site within the estuary, has provided good quality information regarding the risks associated with contact recreation at this site. The pond is partially enclosed by a barrier arm, creating a hydrodynamic environment that favours exchange of water on the incoming tide (refreshed with saltwater), rather than the outgoing tide (refreshed with freshwater) (Eyre, 2009). These characteristics suggest that this area is likely to be protected from faecal contamination arising from freshwater inflows outside of the pond.

Pandora Pond has been monitored as part of Councils Recreational Water Quality Monitoring programme since 1996. Since the 2008/09 season, the indicator has remained enterococci, allowing trends over time to be established from this date.

During 2012/13, the pond was sampled for enterococci (as an indicator of faecal contamination), electrical conductivity (as a proxy for salinity), turbidity and temperature. During this period the site achieved 90% compliance with MfE and MoH (2003) guidelines, indicating that for 18 out of the 20 weeks sampled, the risk of illness associated with contact recreation at this site was low. For two weeks however, elevated levels of bacteria (>280 cfu/100 mL) meant that the risk of illness was considered 'unacceptable' (Figure 3-1). Both of these occasions occurred after periods of significant rain (11 mm 24th and 25th December and 9 mm 7th January), indicating that surface runoff can impact water quality at this site. Given the hydrodynamic regime described above, localised sources should be investigated to determine their role in elevated bacterial concentrations following rainfall events.

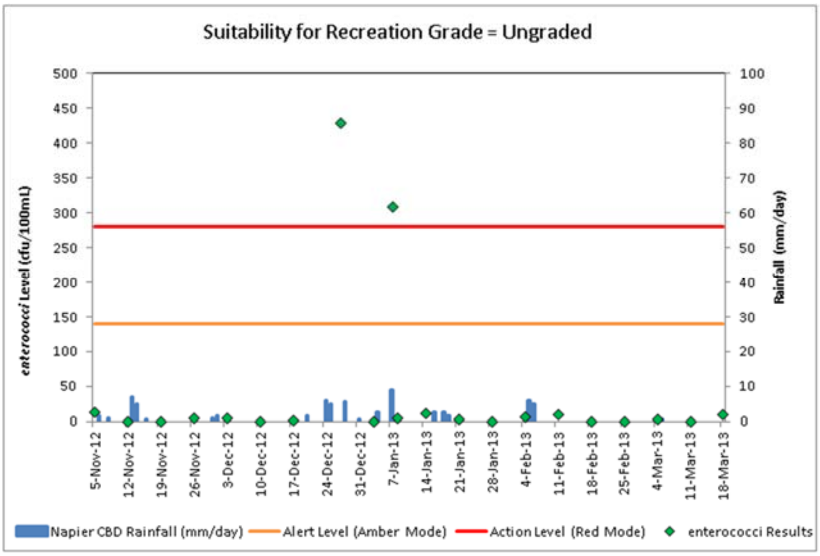

Figure 3-1: Levels of bacterial indicator Enterococci at Pandora Pond, Ahuriri during the 2012/2013 recreational season.

Weekly monitoring provides important information regarding the current state of water quality within Pandora Pond. However, the timing of such information limits our ability to assess the public health risk associated with contact recreation because much of the information only becomes available *after* the period of risk has occurred. This situation arises because the results of analysis only become available 24-36 hours after the samples are collected – during this period, the risk associated with contact recreation is unknown and individuals may be exposed to elevated concentrations of pathogenic organisms. To overcome this limitation, the 2003 guidelines incorporate an approach that couples historical data with a catchment risk assessment to generate a 'Suitability for Recreation Grade' (SFRG). The SFRG is designed to provide a general indication of recreational water quality of a water body at any time, rather than in response to the result from a single sampling event.

A suitability for recreation grade for Pandora Pond was generated at the completion of the 2012/13 season:

- A **moderate catchment risk** was obtained, indicating potential contamination from sources such as stormwater, rural runoff, birds, land drainage and boat mooring
- A **microbiological assessment category of 'C'** was obtained, indicating that elevated bacteria concentrations can occur at times
- Pandora Pond achieved a **'Fair' SFRG**.

This grading indicates that the area is generally suitable for swimming, although caution should be taken if there has been heavy rainfall, or if the water appears discoloured (MFE and MOH, 2003).

3.3.2 Clarity/Turbidity

Turbidity within the estuary has been assessed for a number of discrete projects over the last decade. The most comprehensive data record exists for the period between 1995 and 1998. These data characterise the water quality of the Ahuriri Estuary and the inflows to the estuary. These data were compared with the results from a previous survey (Hooper (1989)) in Fenton (1997).

The turbidity in waterways flowing in to the Ahuriri Estuary generally exceed guidelines for New Zealand lowland streams (5.4 NTU (ANZECC, 2000); Figure 3-2, left). At times, and within certain sub-catchments, turbidity can be extremely high; however they appear to be somewhat buffered within the estuary with only a few sites exceeding guidelines for marine and estuarine waters (Figure 3-2, right). Typically higher turbidity values are observed in the upper reaches of the estuary (Quarantine and Watchmen Rd), with elevated values at sites in proximity to incoming waterways (e.g. Low level bridge, Tyne Street). In general turbidity in the mid to lower estuary is within, or close to, guideline values for aquatic ecosystems (10 NTU). These values are unlikely to negatively impact on contact recreation except during periods of heavy rainfall, when turbidity may transiently reach values of 130 NTU.

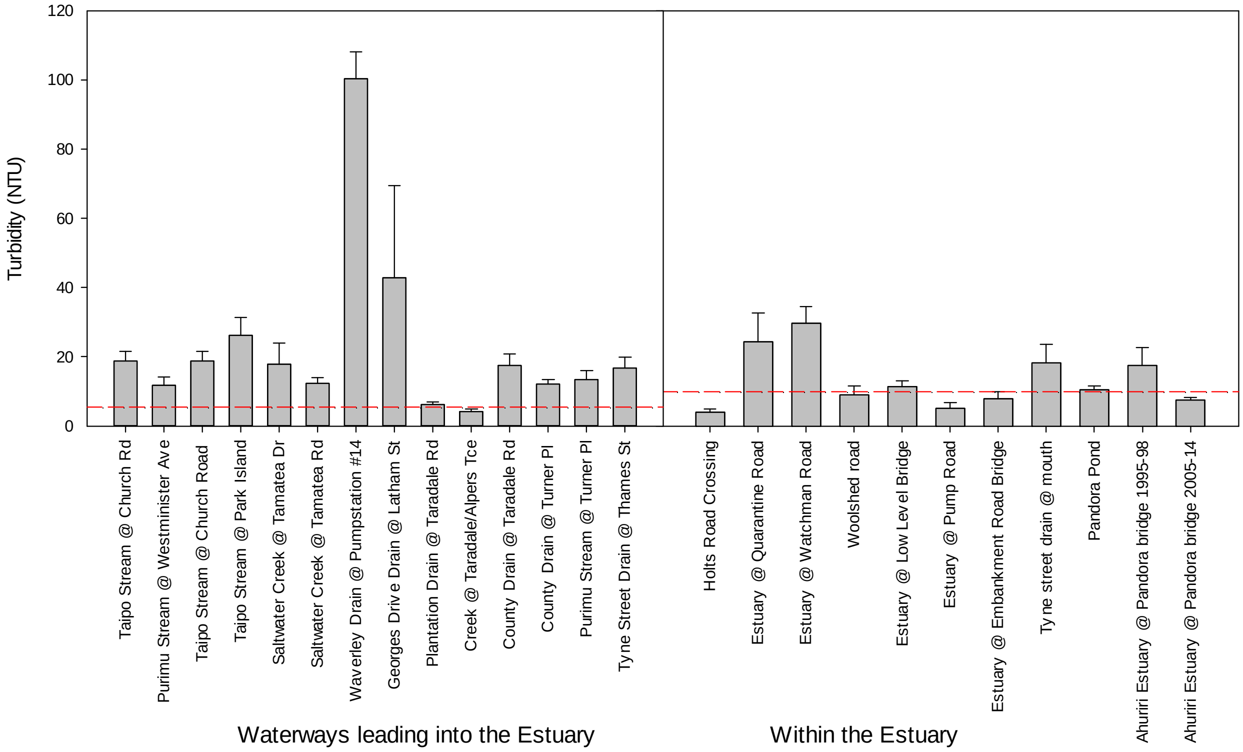

Figure 3-2: Turbidity measured in inflows to the Ahuriri Estuary and within the Ahuriri Estuary *n*=4-37 Red line = ANZECC trigger levels for aquatic ecosystems for freshwater (left) and estuaries (right).

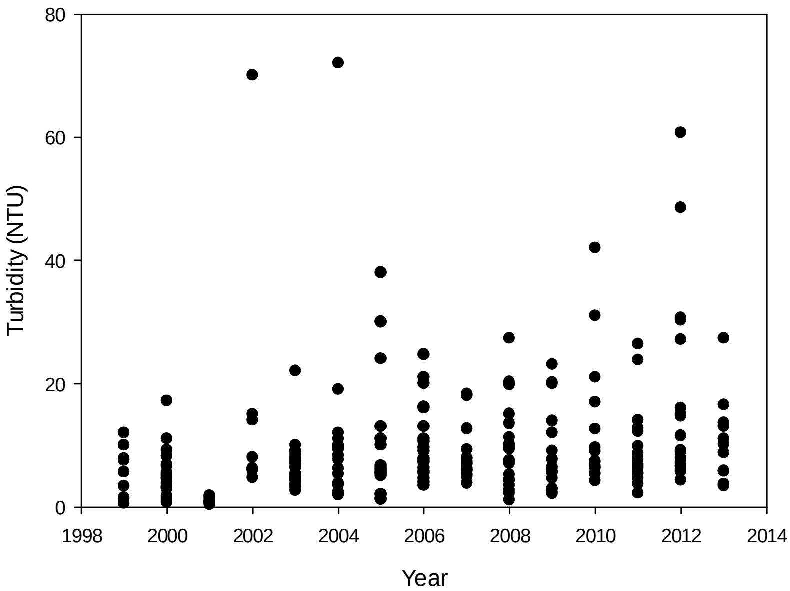

Figure 3-3: Turbidity levels at Pandora Pond, Ahuriri Estuary between 1999 and 2013. n=20 per annum

The data described above was collected mainly during the period 1995-98, with more recent data restricted to the Pandora Bridge site. The Pandora Pond however has consistently been monitored for turbidity since 1999 as part of the Recreational Water Quality Monitoring programme. With the exception of 2004, no significant increase or decrease in turbidity has been observed (Figure 3-3).

Therefore, the turbidity at the Pandora Pond site does not appear to have significantly changed since 1998.

3.3.3 Algae

Algae, both macroscopic (large, found on the sediment surface), and microscopic (small, plants found within the water column and on the sediment), are normal constituents of a healthy estuarine ecosystem. In areas of high nutrient loading however, algal numbers or cover can become excessive, causing nuisance growths in terms of visual amenity, as well as negatively influencing sediment quality and water chemistry.

Macroalgae

The largely channelised nature of the Ahuriri Estuary minimises the likelihood of prolific algal growths. In depositional areas (where flow is less rapid or obvious), algal growth has generally been restricted to small patches of ephemeral species (e.g. *Ulva sp.*) during the spring/summer period, persisting at times through to autumn.

Given the nature of the estuary and the moderate sediment nutrient concentrations, prolific algal growth that would adversely affect contact recreation within the lower estuary area (more commonly used for contact recreation) is unlikely.

Chlorophyll *a*

A few previous studies have detailed the nutrient status of the Ahuriri Estuary waters. These identified that inflows to the estuary have delivered high concentrations of both phosphorus and nitrogen into the main, 'true' estuary (Fenton, 1997, Hooper, 1989). Although the estuary has previously been described as eutrophic (Hooper, 1989, Knox, 1979), the decrease in phosphorus concentrations measured between 1989 and 1997 and currently indicate that the trophic state of the waters may have decreased more recently. Conversely, nitrogen concentrations (particularly ammoniacal nitrogen) appear to have increased over the period 1989 – 2013 (Fenton, 1997, Hooper, 1989). The current trophic status of estuarine waters, including the contributions of nutrients from various inflows and land-uses should be investigated further.

That said, chlorophyll *a* concentrations on estuarine sediments were assessed as part of a specific water quality study in 1998 and 2000 (Figure 3-4). These data can provide important information regarding the *relative* nutrient status of inflows to the estuary. This work highlighted the role of inflows in determining overall quality of estuarine water.

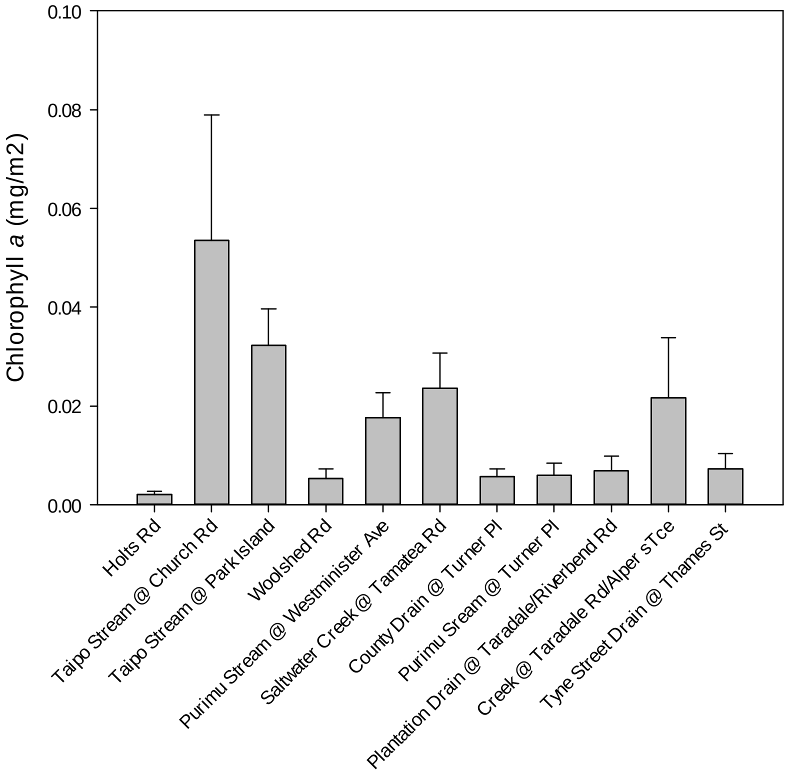

Figure 3-4: Sediment chlorophyll *a* concentrations in the Ahuriri Estuary between 1998 and 2000.

More recently, sampling in the Ahuriri Estuary has been undertaken as part of:

- the Nearshore Coastal Water Quality Monitoring Programme (at Pandora Bridge),
- the Estuarine Water Quality Monitoring programme to support policy development (at six locations between Watchman Rd and Pandora Bridge) (waters),
- the Estuarine Ecological Monitoring Programme (sediments collected at multiple locations across the estuary).

The waters of the upper estuary appear to be fairly eutrophic, consistent with the findings of previous reports. However by approximately the middle of the estuary, chlorophyll *a* levels have dropped below trigger levels, indicating that dilution and flushing from marine waters is moderating nutrient concentrations and algal growth (Figure 3-5).

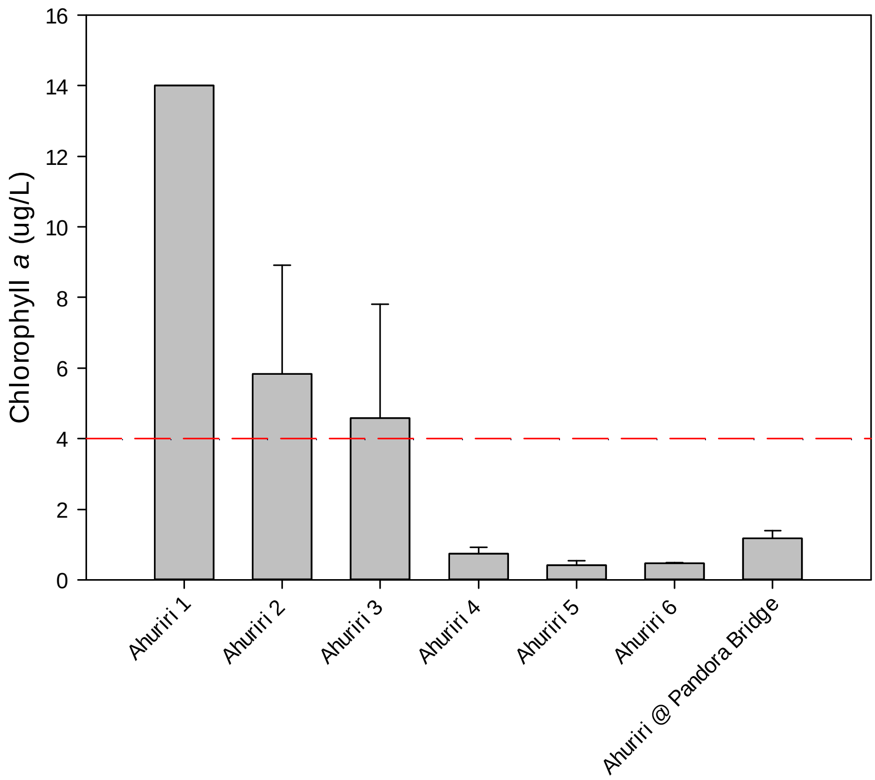

Figure 3-5: Chlorophyll *a* levels of water samples taken within the Ahuriri Estuary between March and April 2013 (Ahuriri 1-6), and 2006-2013 (Ahuriri at Pandora). Redline = ANZECC trigger value for south-east Australian estuaries.

From a contact recreation perspective, waters of the Ahuriri Estuary are unlikely to support algal growth to an extent that would impair contact recreation. This assessment excludes the periodic and transient blooms which can significantly increases chlorophyll *a* concentrations and reduce visual clarity. Such events are infrequently reported for the Ahuriri Estuary.

Harmful algal blooms (HABs)

Harmful algae blooms (and associated marine biotoxins) occur infrequently in Hawke Bay and estuarine areas. These are defined as species that may release toxins (e.g. *Gymnodinium catenatum, Pseudonitzchia, Karenia, Dinophysis*) which can be harmful if ingested via water or contaminated shellfish, resulting in serious illness. Additionally, species may be present in bloom numbers that do not produce toxins, but cause irritation to the eyes or skin. These blooms may also have environmental impacts, such as depletion of dissolved oxygen concentrations in the water column.

Marine biotoxins were routinely monitored by the Public Health Unit on behalf of the Food Safety Authority until recently, when this function was transferred to the Ministry of Primary Industry (MPI). During autumn 2005 and 2006, significant parts of the Hawke's Bay coastline were closed due to the presence of marine biotoxins. In August 2012, a large and persistent bloom of *Akashiwo sanguine* (red tide) was observed along most of the east coast of the North Island, and in the following month a bloom of *Pseudo-nitzschia spp.* (produces the neurotoxin domoic acid) was observed off Napier; this bloom also included the red tide, *Mesodinium rubrum*. During these times, contact recreation would have been discouraged along coastal beaches or estuaries affected by these organisms.

3.4 State of the Ahuriri Estuary for contact recreation

Based on information derived from various monitoring programmes operated by Hawke's Bay Regional Council, the Ahuriri Estuary may be considered as "fair" for contact recreational purposes (*see* appendix one). This grading indicates that:

- Ahuriri Estuary waters are generally suitable for swimming.
- Elevated bacteria concentrations can occur at times.
- Caution is required during periods of heavy rain or when the water appears discoloured.

Faecal contamination of the estuary is associated with stormwater inflows, runoff from rural land uses and direct deposition of faeces by the high numbers of birds for which the estuary is valued. Throughout the summer period when water quality monitoring indicates an elevated risk of illness due to high numbers of faecal bacteria, the Regional Council work in collaboration with the Public Health Unit of the Hawke's Bay District Health Board to inform the public of the risk through signage and media releases.

Sewage discharges may cause infrequent problems; these are not considered to be a persistent problem.

Should the community express a desire for improved water quality, application of techniques such as faecal source tracking would be useful in identifying the sources of faecal indicator organisms, which in turn would allow management strategies to be targeted on these sources.

Other water quality metrics, such as visual clarity and algal growth do not generally impair recreational values.

4 Food gathering

4.1 Background

The Ahuriri Estuary has traditionally been an important food source for local hapu and whanau. Maori occupation dates back as far as the 12th century, and the estuary was used not only to provide food to the local area, but also as a resource that aided in the development of trade and social relationships with neighbouring hapu (Black and Ataria, 2008).

Prior to the 1931 earthquake (which dramatically altered the physical nature of the estuary), the estuary was used to collect fish (mullet, kahawai, flounder, herring), shellfish (freshwater mussel, crayfish, mussel, horse mussel, pipi, mud snail, periwinkle, cockles), and eels. However, in the aftermath of the earthquake and due in part to drainage, reclamation, diversion and development, the species distribution and abundance within the estuary was significantly altered (Black and Ataria, 2008).

Figure 4-1: Dead fish being cleared from the Ahuriri Estuary post- 1931 earthquake. Source: Hawke's Bay Museum.

More recently the estuary has continued to provide valuable food resources for Napier residents. The collection of cockles (*Austrovenus stutchburyi)* and flounder is widespread within the estuary, with Yellowbelly founder (*Rhombosolea leporine*), Sand flounder (*Rhombosolea plebeian)*, Yellow-eyed mullet (*Aldrichetta forsteri*), and Grey mullet (*Mugil cephalus*) all common in the lower estuary (Ataria et al., 2008).

4.2 Threats

As filter feeders, cockles filter large volumes of water, ingesting the small plants living in the water for nutrition. They are therefore highly susceptible to the contaminants present both in the water, and attached to any particulates they ingest from the water column. They also have the potential to accumulate contaminants associated with particulate material within their gut. In turn, humans consuming whole cockles collected within these waters will ingest any contaminants that have been retained within the cockle gut. Similarly, flounder can ingest sediment particles during feeding, which makes them vulnerable to accumulating contaminants from sediment. For this reason, both cockles and flounder may be used to assess general environmental contamination.

Contaminants likely to affect food gathered within the Ahuriri Estuary may enter the water and sediments in the estuary through similar pathways to the contaminants likely to impair contact recreation. Sources of faecal contaminants that can make shellfish unsuitable for harvesting are described in section 3.2. The quality of shellfish and fish harvested from the estuary may be compromised by unacceptable concentrations of contaminants (including trace metals as indicators of pollution) arising from stormwater discharges. Stormwater derived from residential subdivisions may contain elevated concentrations of copper from plumbing fittings, and zinc from roofing material, as well as several other toxic metals associated with road runoff. Stormwater derived from industrial areas have also been shown to contribute elevated levels of toxic metals to waterways – these may accumulate in sediments within the waterways, (Smith, 2011), as well as sediments within the estuary itself (Smith, 2010).

Previous studies have highlighted the impact that accidental discharges of chemicals from industry may have on shellfish quality. Concentrations of chromium and lead within the Tyne Street drain were deemed 'unacceptable', and at levels 'well above' New Zealand averages for estuaries (Hooper, 1989). A spill of the timber treatment chemical Tanalith NCA in 1987 resulted in concentrations of chromium in cockles that were 60% higher than in adjacent area (Hooper, 1989). It is likely that episodes of acute industrial discharge, as well as more pervasive discharges of trace amounts of these metals, may contribute to elevated concentrations of toxic metals within shellfish and fish.

When assessing the changes associated with food gathering, it is necessary to consider:

1) The presence or absence of contaminants in edible resources, as well as
2) How contaminant profiles may indirectly affect the likelihood of encountering an edible resource e.g.:
    a. numbers may be reduced by impairment of habitat type and quality, or
    b. an increase or reduction in prey species may decrease or increase the numbers of edible species.

Assessment of these factors is not within the scope of the current study, but this requirement has been identified for further consideration.

4.3 Current state

4.3.1 Faecal bacteria

The Microbiological Water Quality Guidelines provide guidance regarding an the level of faecal coliform contamination in waters during a shellfish gathering season (MfE and MoH, 2003). These guidelines indicate that over a season:

- median faecal coliform concentrations should not exceed 14 MPN (Most Probable Number) /100 mL, and/or
- for 90% of samples, faecal coliform concentrations should not exceed 43 MPN/100 mL.

These guideline values are based on the 1995 Ministry of Agriculture and Forestry 'Shellfish Quality Assurance Circular' and the 1992 Department of Health 'Provisional microbiological water quality guidelines for recreational and shellfish-gathering waters in New Zealand' for export standard shellfish.

Recent concerns regarding appropriateness of these guidelines was incorporated into a review document produced for MfE (Bolton-Ritchie et al., 2013), this has resulted in working groups being established to address a review of the guidelines by late 2013. More recently the Ministry of Health have stated that they do not recommend collecting shellfish from areas affected by urban runoff (Paul Prendergast (MoH) *pers.comm.*).

That said, HBRC have collected information on shellfish gathering waters within Ahuriri Estuary in line with MfE and MoH guidelines (2003) since 2006. The results are detailed in Table 4-2 below:

Table 4-1: Levels of compliance with MfE and MoH guidelines for shellfish gathering waters, in Ahuriri Estuary.

Year	Median concentration (MPN /100mL)	Proportion of samples >43 MPN/100 mL (%)	Compliant with guideline values?
2006/07	9	20	No
2007/08	14	10	Yes
2008/09	10	5	Yes
2009/10	14	20	No
2010/11	39	40	No
2011/12	5	20	No
2012/13	3	0	Yes

The compliance of waters in the Ahuriri Estuary with seasonal guidelines for water quality at shellfish gathering sites is variable (Table 4-2). This variability exemplifies one of the underlying concerns with the current guidelines. This is that they produce highly variable results for the same shellfish gathering waters, hindering the ability to provide consistent, reliable communication regarding the level of risk with the public.

However,

- the historic levels of non-compliance and;
- the recommendation that shellfish should not be gathered from areas influenced by urban runoff;

indicate that water quality in the Ahuriri Estuary should not be considered generally appropriate for shellfish gathering purposes.

This view is supported by research completed in the Ahuriri Estuary in 2004, which showed that at times *E. coli* concentration in shellfish flesh collected from the estuary were higher than those considered acceptable for commercial harvest (ESR, 2004). Although guidelines do not currently exist for acceptable *E. coli* concentrations in shellfish flesh collected for recreational purposes; commercial limits may be applied, noting that these are likely to be more conservative (provide a higher level of protection from infection).

A number of factors support the need for further investigation of water quality pertaining to recreational shellfish gathering in the Ahuriri Estuary:

- The Ahuriri Estuary is used extensively for recreational fishing and some cultural harvest
- Greater certainty regarding the general suitability of water in the estuary for shellfish gathering
- Sources of faecal contaminants that currently compromise microbiological water quality need to be identified and targeted for remedial action.

4.3.2 Toxic metals

Toxic metals are delivered to the estuary (water and sediments) through numerous waterways that discharge stormwater to the estuary (Ataria et al., 2008, Hooper, 1989, Smith, 2010, Smith, 2011). Concentrations of metals in the water column and sediments may render shellfish and fish unsuitable for consumption.

Shellfish flesh (cockles) was previously tested as part of a study into the effects of boat maintenance and repair facilities on sediments in the Inner Harbour (Strong, 2005). This report showed that levels within shellfish flesh fell within guidelines for human consumption, and so were unlikely to pose a risk for human health. More recently, a review undertaken in association with Te Taiwhenua a Te Whanganui-a-Orotu comprehensively assessed the concentrations of industrial and stormwater contaminants in the sediments of the Ahuriri Estuary, as well as within shellfish and fish flesh (Ataria et al., 2008). This investigation showed that at the time of the study, the risk to human health associated with consumption of cockles and yellowbelly flounder could be considered negligible. For example, it would be necessary to consume 6 kg of cockles or 11 kg of flounder per day to exceed the tolerable limit for zinc, and 11 kg of cockles or 123 kg of flounder to exceed the tolerable daily intake limit for copper.

Ataria et. al. (2008) noted that for tangata whenua, the presence of contaminants in the water from discharges, even at levels considered safe in relation to food safety standards, was regarded as unacceptable.

4.4 State of the Ahuriri Estuary for food gathering

There is relatively little information regarding the state of food resources within the Ahuriri Estuary. While Hawke's Bay Regional Council undertakes monitoring of waters overlying popular shellfish gathering areas, comparing measured concentrations with national guideline values, there is some concern regarding the relevance and applicability of these guidelines for assessing the risks to human health. Available information has been derived from single study events of variable duration and robustness. The most comprehensive study undertaken to date related the effects of stormwater contaminants on edible shellfish resources.

In general, shellfish gathered within the Ahuriri Estuary are likely to contain relatively elevated faecal contaminant concentrations. Further work is required to assess whether current contaminant concentrations do restrict this activity, and how these relatively elevated concentrations may be reduced.

Although shellfish and fish gathering is not compromised by levels of contamination that constitute immediate health risks, the presence of stormwater contaminants is likely to impose a barrier to food gathering by tangata whenua.

5 Conclusions and recommendations

This report describes the current state of knowledge for the factors likely to influence contact recreation and food gathering within the Ahuriri Estuary.

The estuary may be considered fair for contact recreation, recognising that at times inputs of faecal material may contribute to high concentrations of faecal bacteria at the Pandora Pond site.

Should contact recreation be considered as compromised by faecal contamination, and a desire exist to improve water quality, techniques such as faecal source tracking would assist in identifying source areas and in focusing management or remedial measures.

Little information exists regarding the impact of land-use on food resources within the estuary. Existing information indicates that concentrations of toxic metals in edible resources harvested in the estuary do not currently constitute a risk to human health. The elevated concentrations of contaminants observed in the inflows to the estuary indicate that there is a potential for adverse impacts on edible resources – this is an issue that needs to be considered in future.

Faecal contamination of resources indicates that the estuary should *not* be considered suitable as a safe source of shellfish for human consumption. Further work is required at a national level to develop appropriate guidance on assessing the risks of shellfish gathering to recreational fishers.

Regardless, the Ahuriri Estuary does support a significant recreational fishery and further work is required to quantify the public risk associated with consumption of food harvested from the estuary. At this stage it is unclear where responsibility for this assessment lies (Public Health Unit, Food Safety Authority (MPI), or Regional Council). Continuing monitoring of toxic metals, other chemical contaminants and faecal indicator bacteria within edible resources (cockles and flounder) in the estuary is recommended to better assess human and ecological health risks, inform public health and identify appropriate catchment management actions that will achieve community objectives for the area.

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7 Glossary of abbreviations and terms

cfu	Coliform Forming Units
E. coli	*Esherichia coli*
HAB	Harmful Algal Bloom
HBRC	Hawke's Bay Regional Council
MfE	Ministry for the Environment
MoH	Ministry of Health
MPI	Ministry of Primary Industries
MPN	Most Probably Number
NTU	Nephelometric Turbidity Units
SFRG	Suitability for Recreation Grade

8 References

ANZECC (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000. ANZECC and ARMCANZ (eds), Australian and New Zealand Environment and Conservation Council, Australia.

Ataria, J., Tremblay, C., Tremblay, L., Black, M., Kaukau, M., Kemp, R. and Mauger, J. (2008) He Moemoea mo Te Whangaui-a-Orotu: A vision plan.

Black, M. and Ataria, J. (2008) Napier Estuary Literature Review, p. 31, Landcare Research, Lincoln, New Zealand.

Bolton-Ritchie, L., Greenfield, S., Madarasz-Smith, A., Milne, J., Stevenson, M. and Walker, J. (2013) Recreational Water Quality: A practitioner's discussion on the limitations of the 2003 national guidelines.

Chague-Goff, C., Nichol, S.L., Jenkinson, A.V. and Heijnis, H. (2000) Signatures of natural catastrophic events and anthropogenic impact in an estuarine environment, New Zealand. Marine Geology 167, 285-301.

Comerty, P.S., D.A. (1996) A directory of wetlands., p. 395, Department of Conservation, Wellington.

ESR (2004) Ahuriri cockle results, p. 1, ESR, ESR.

Eyre, T.M. (2009) The Sediment Dynamics of Ahuriri Estuary, Napier, New Zealand, University of Waikato & Universitat Bremen, Hamilton, New Zeland.

Fenton, J.A. (1997) Ahuriri Estuary Water Quality: Review of water quality in the estuary and catchment area, p. 69, Blue Tear Environmental, Napier, New Zealabnd.

HBRC (2012) Hawke's Bay Regional Coastal Environment Plan, HBRC.

Henriques, P.R., Binmore, H., Grant, N.E., Anderson, S.H., Duffy, C.A.J. (1990) Coastal Resource Inventory First Order Survey: Hawke's Bay Conservancy, p. 78 + Department of Conservation, Wellington.

Hooper, G. (1989) Ahuriri Estuary Water Quality Study, p. 37 +, Hawke's Bay Regional Council.

Kilner, A.R. and Akroyd, J.M. (1978) Fish and Invertebrate Macrofauna of the Ahuriri Estuary, Napier, p. 79, Ministry of Agriculture and Fisheries, Wellington, New Zealand.

Knox, G.A. (1979) Ahuriri Estuary: An Environmental Study, p. 84, University of Canterbury, Christchurch, Canterbury.

Lee, J.W. (1977) Hawke's Bay Harbour Board's Proposal to Dredge Humber Street Pond. Board, H.s.B.C. (ed), p. 9, Wellington, New Zealand.

MfE (1994) Water Quality Guidelines No. 2. Environment, M.f.t. (ed), Ministry for the Environment, Wellington, New Zealand.

MfE and MoH (2003) Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas, Ministry for the Environment, Wellington.

NZFSA (1995) Microbiological Limits for Food. Authority, F.S. (ed).

Rycroft, C. (2000) Napier Inner Harbour & Lower Ahuriri Estuary Point Source Discharges, p. 17, Hawke's Bay Regional Council, Napier, New Zealand.

Smith, S. (2010) Monitoring of benthic effects of stormwater discharges at sites in the Ahuriri Estuary: 2010 Survey, p. 52.

Smith, S. (2011) Fate, transport and extent of sediment associated trace metal contaminants in Napier urban waterways: Purimu Stream and County Drain, p. 39.

Strong, J. (2005) Antifoulant and trace metal contamination of the sediments from the Napier Inner Harbour., p. 30, EAM Ltd, Napier.

Appendix A Assessing microbiological water quality for contact recreation

The "Microbiological water quality guidelines for marine and freshwater areas" (MfE and MoH, 2003) were developed to improve the communication of risk to recreational water users. In a departure from earlier assessments of recreational water quality, the 2003 guidelines required two related activities to be undertaken in order to assess suitability for recreational use:

- risk grading, allowing a Sanitary Inspection Category to be assigned to the water body and associated catchment, and
- allocation of a Microbiological Assessment Category, using routine monitoring data.

Combining these indices allows an overall Suitability for Recreation Grade to be assigned, which is the basis for informing the public regarding health risks associated with recreation at a particular location.

Significant monitoring is required to classify recreational water. A minimum of 20 data should be acquired over the recreation season. Ideally the classification should be based on data collected over a five year period. The classification makes use of 95th percentile concentration values.

Weekly Monitoring

The MfE and MoH (2003) guidelines also identify two tiers of surveillance activity. These actions are based on maintaining the risks of infection below identified thresholds. A "traffic light" coding system is used:

- in **surveillance** mode (green), where concentrations of indicator organisms in individual samples remain below specific thresholds, routine monitoring continues.
- where the surveillance concentration threshold is exceeded by a single sample result:
  - **alert** (amber) or
  - **action** (red) monitoring modes commence.
- sampling frequency increases (to daily), the source of pollution is investigated and warning signs may be erected.

The monitoring thresholds for fresh and saline waters associated with these "traffic light" are detailed in Table A-1.

Table A-1: Status levels and management actions associated with measured faecal indicators and illness risk. Source MfE&MoH, 2003

Colour code	Status	Marine waters (enterococci /100 mL)	Freshwaters (*E. coli* /100 mL)	Action
Green	Surveillance	All results ≤140	All results ≤260	Continue routine weekly monitoring
Amber	Alert	Single sample result >140	Single sample result >260	Increase to daily sampling, identify source of contamination
Red	Action	2 consecutive sample results >280	Single sample results >550	Increase to daily sampling, identify source of contamination, erect signs, inform public

Suitability for Recreation Grade (SFRG)

In order to grade a recreational water body, two activities must occur:

- the Microbiological Assessment Category (MAC) must be established from existing or collected microbiological data; definitions for the different categories are given in Table 4-3
- the Sanitary Inspection Category (SIC) must be established (classifications are Very High, High, Moderate, Low or Very Low; these refer to risk of contamination and are determined for a specific water body by using the SIC flow chart provided in the guidelines (MfE and MoH, 2003).

The Suitability for Recreation Grade (SFRG) provides five grades (very poor to very good) that summarise the potential health risk associated with primary recreation (such as swimming or surfing) at a site. The process for generating a SFRG is summarised schematically in Figure A-1.

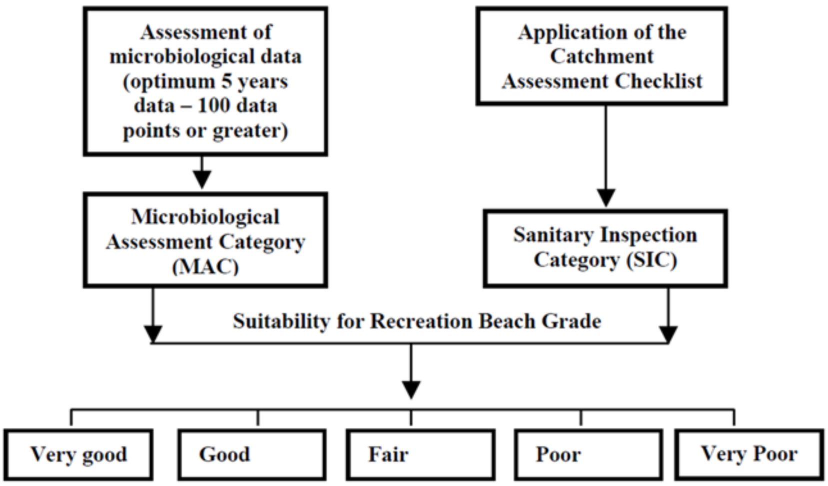

Figure A-1: Suitability for recreation grade schematic.

The grades can then be used to communicate *typical* risk of contact recreation in a specific water body to water uses as described in Table A-2.

Table A-2: Explanation of suitability for recreation grades.

SFRG	Description*
Very Good	The site has generally excellent microbial water quality and very few potential sources of faecal pollution. Water is considered suitable for swimming for almost all of the time.
Good	The site is considered suitable for swimming for most of the time. Swimming should be avoided during or following heavy rain.
Fair	The site is generally suitable for swimming, but because of the presence of significant sources of faecal contamination, extra care should be taken to avoid swimming during or following rainfall or if there are signs of pollution such as discoloured water, odour, or debris in the water.
Poor	The site is susceptible to faecal pollution and microbial water quality is not always suitable for swimming. During dry weather conditions, ensure that the swimming location is free of signs of pollution, such as discoloured water, odour or debris in the water, and avoid swimming at all times during and for up to three days following rainfall.
Very Poor	The site is very susceptible to faecal pollution and microbial water quality may often be unsuitable for swimming. It is generally recommended to avoid swimming at these sites.

* from http://www.mfe.govt.nz/environmental-reporting/fresh-water/suitability-for-swimming-indicator/suitability-swimming-indicator.html).