The importance of the social components of biotransformation in the treatment of wastewater

Part 2: Water user experiences, perceptions and aspirations

Te Turanganui a Kiwa 2013

Te Turanganui a Kiwa Gisborne Wastewater Technical Advisory Group

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Contents

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Nga Mahi Te Taiao
ENVIRONMENT & NATURAL RESOURCES
Research Education Planning Development

Executive summary

Background

In June 2010, the author completed a survey of available information on the environmental, social and economic characteristics of the Gisborne Turanganui community, prior to the commissioning of the wastewater treatment plant in January 2011 (*Te Moananui o Te Turanganui a Kiwa, Social Outcomes Evaluation of the Gisborne City Wastewater Treatment Project 2010 to 2013, Part 1: Baseline Information 2010*). Included in the suite of characteristics were:

- A description of community values for the coastal environment of Turanganui a Kiwa (the Bay);
- A background to tangata whenua values and responses to discharge of wastewater to the Bay;
- Perspectives of the submitters over the Resource Management Act 1991 process relating to wastewater management since 1993;
- An introduction to social (local household) economy including
    - Coastal resource harvesting
    - Community health, recreation and physical wellbeing
- A health risk evaluation of the wastewater discharge prior to the new treatment plant commissioning, particularly regarding contact recreation and shellfish gathering;
- The role of the rivers in the Bay's water quality.

The current report provides a background to the social components of wastewater management in the context of the experiences, perceptions, and aspirations of key stakeholder water user groups, and the broad public health landscape associated with water quality in Te Turanganui a Kiwa Gisborne, two and a half years on from the commissioning of the Biological Trickling Filter treatment plant at the start of January 2011. The scope of the report is altered from that of 2010, and now includes:

- A targeted and detailed discussion and questionnaire survey of water users in the Bay, including their experiences, perceptions and aspirations for the takutai moana (coastal marine environment) and the waterways feeding the Bay;
- A discussion and open questionnaire survey of wider community views, gathered from public events (the A&P Show and the Tairawhiti Environment Conference) and from the *He Awa Ora, He Tai Ora, Healthy Rivers, Living Sea* Facebook page;
- A survey of the notifiable disease records from the Institute of Environment and Science Research (ESR) and other sources to assess any identifiable

patterns of change in levels of notified disease potentially associated with coastal water use in the Gisborne Tairawhiti region.

The primary purpose of the *2010 Baseline Evaluation* and the current *Social Components of Wastewater Te Turanganui Gisborne* research is to provide an analysis of the social components of biotransformation in the treatment of Gisborne's municipal wastewater, particularly in the context of the commissioning of the plant at the beginning of 2011. This will form a part of the BTF Monitoring Study. This is a requirement embodied in Clause 4A (iii) of the 2009 Resource Consent Decision, namely to:

> *Investigate through surveys, literature reviews and research the importance of social, cultural and environmental components of biotransformation in the treatment of wastewater.*

In the wider context of Clause 4A of the consent conditions, this research project is anticipated to further inform:

- *A definition of biotransformation and the extent of biotransformation being achieved by the BTF Plant;*
- *Appropriate parameters and a monitoring programme for ongoing assessment of biotransformation;*
- *What additional treatment steps (if any) are required to achieve biotransformation and other requirements that may be necessary to improve the quality of the discharge to avoid adverse effects* (Resource Consent, Clause 4A).

Other strands of work from the WTAG group that this report will be included alongside are:

- A review of the current wastewater treatment plant and receiving environment monitoring data, and an assessment of the relevance of the existing monitoring methodology and parameters;
- Analysis of the biological composition of the wastewater treatment process and effluent stream;
- Analysis of the ecology and trophic functioning of the BTF plant;
- A survey of new and emerging chemicals in the waste stream and the ability of the BTF process to 'biotransform' these;
- Options for utilisation of the sludge and solids from the wastewater;
- Investigating the options for constructed wetlands for tertiary effluent processing;
- A broad survey of the options for alternative use and disposal of Gisborne Te Turanganui a Kiwa municipal wastewater.

Altogether, we received input into the survey from approximately 250 people. Aside from the participating water user representatives and focus group members, 98% of the 114 survey questionnaire respondents also utilised these waters regularly, 36% of the primary contact water users (surfing, swimming, surf lifesaving, paddling) doing so more than ten times per month. 64% of all water user questionnaire respondents had been participating in these activities for greater than 15 years. In this context for the purpose of this summary, the input from our overall discussions and survey questionnaire have been reported on together. This input is classified into the nine key themes outlined below.

Water quality in the Bay

The theme of water quality in the Bay was the one that received the widest spread of responses. Many people simply do not swim or surf in the Bay and discourage their families from doing so because of perceptions around poor water quality and faecal contamination. Many do use these waters, however, and there is a widespread perception that when there has been little or no rain and the winds have been offshore for some time, the inshore waters are safer to use. This changes, however, with wind and swell direction and rain.

> *When we pass through the plume* [blown in by a southerly wind] *out past the bouy, we rinse our arms and paddles in the cleaner seawater*.

Nevertheless, 19 of the 24 questionnaire respondents who had noticed a change in water quality in the Bay noted an improvement, although this was far from universal, possibly as optimum surfing conditions frequently occur just after onshore storm conditions. In this context, locals have tended to adopt a fatalistic approach.

> *It* [the sewage discharge into the Bay] *is disgusting. It's just out there and we're in it all the time.*

Monitoring information from the wastewater treatment plant and the receiving environments of the Bay indicate an improvement in the quality of the discharge and potentially of the Bay receiving waters, notably in levels of faecal indicator organisms (*Enterococci* bacteria). Nevertheless, weather patterns are expected to play a major role in the quality of the waters experienced by contact water users, particularly as the discharge does not yet meet the standards ultimately required by the 2009 resource consent (Watson *et al* 2009).

Water quality in the rivers

Perceptions of the quality of the waters in the city's river reaches was far more singular amongst water users, particularly waka paddlers, kayakers, and surf lifesavers who use the rivers for training throughout the year. While there was a unanimous antipathy to the discharge of raw sewage to these waters, and a feeling that these needed to be stopped as soon as possible, there was also an understanding of the wider catchment impacts on water quality here, including diffuse agricultural discharges and urban stormwater and port activities. It appears that paddlers who regularly utilise both the river and coastal waters feel that addressing levels of contamination of the rivers is possibly the more pressing issue.

> *Yea the water quality of the river is a huge concern to us as waka ama paddlers and it's something that raises its head as a topic both in our clubs and as club members. Individually we always talk about the rubbish and sewerage that's going in there.*
>
> *We're one of the top voluntary organisations around and we're doing this for our people and we've got this barrier of the water quality.*

Recreational water quality monitoring supports this perception of high contaminant loadings in the Gisborne city' rivers, as does an initial analysis of human *Norovirus* in shellfish in the Turanganui River area undertaken prior to the BTF treatment plant commissioning. Further work is necessary, however, to ascertain the influence of weather patterns, stormwater, sewage overflows and sediment contamination on water quality here.

Health risks

Participants were generally aware that it is difficult if not impossible to categorically implicate the sewage discharge into the Bay with specific illnesses, without comprehensive epidemiological studies of individuals, disease vectors and infection pathways. This perspective was reflected in the divergence of opinion amongst water user representatives around likely sources of health risk contamination in the Bay. Reference was made, however, to a sense of something 'undesirable' about the waters, and continuing reports from water user group members of specific illnesses, and concerns about being unwell related to using the waters of the Bay. This was often referred to as being particularly relevant after onshore winds or rain when the waters become discoloured.

Our survey of ESR notifiable disease statistics also reflects an uncertainty about actual levels of illness that might be associated with contact water use in the Te Turanganui a Kiwa environment. Nevertheless, recent reports of gastrointestinal disease outbreaks in the district continue to be of concern.

In general, in relation to the management of health risks by primary contact water users in the Bay, the avoidance of surfing or paddling after heavy rain, and trying to avoid contact with sediments as much as possible (e.g. by paddling only at high tides) were identified as key mitigation strategies. Nevertheless, surfers usually do take to the waters after storm events when the waves are at their best and potentially the risks highest, and paddlers do continue to train even when the waters are discoloured.

> *We know sometimes that there's a risk paddling especially when the river is discoloured, but it's our sport, our life.*

The potential for serious health risks should an intense rainfall event coincide with the summer influx of visitors was referred to by participants. More robust environmental monitoring practices including community participation, and the role of tangata whenua cultural values around the discharge of human waste to water were also important discussions.

In response to this Question 14, *Over time, and particularly over the last three years, have you noticed any differences in the numbers of people you know who might have become ill after swimming or surfing in the Bay, gathering seafood etc?* Twenty two water users stated that they did know of people who had become ill, including themselves, and this seemed to have increased over the last three years. There was a general feeling that there was a real risk of becoming unwell from using the Bay waters, and participants had adjusted their behavior accordingly.

> *I won't let the groms' surf pipe which is a shame as it is a great learner break.*
>
> *Have always known people to get sick at some stage after surfing in the bay*
>
> *Yes waka ama whanau noticing scabs, people got sick after eating the pipi in August.*

When asked to describe specific experiences of untreated sewage overflows and discharges (Question 23), at October 19th 2013 of the 50 people (62% of respondents to this question) who answered that they had experience of such events, 45 gave details.

A common theme throughout the discussions and survey responses was the need for an integrated approach to management of the contaminants entering our river and coastal environments.

> *There is a reality that our infrastructure needs an upgrade. That will take time and resources. The objective to remove sewage from the outfall means every effort to tidy up, as best we can, the current use of our valves is an important and priority task. The reality that the rivers carry high levels of coliforms from animals does not mean the sewage overflows can be condoned. It does mean the land managers up stream need to lift the game and reduce/manage run off better.*

Kai moana resources

Currently, flounder and crayfish are the only commercial fisheries in the Bay (with a total of three fishery quota holders) although there are a range of other species with commercial potential (e.g. Tua tua, *Paphies subtriangulata*; surf clam *Mactra* species). There are, however, a wide range of species collected by recreational and customary and subsistence kai gatherers.

There was an understanding amongst all participating kai gatherers that there are multiple influences on coastal species abundance and quality, and this was reflected in the discussions about these resources. Health risks associated with gathering kaimoana from the Bay environment was frequently noted, however, providing a similar response as other recreational water user groups who view avoidance as a necessary harm avoidance strategy.

> *I choose not to gather kai moana from the Bay anymore - don't think it's safe.*

Nevertheless, reference to continuing harvests, particularly of bivalve shellfish, was a common theme.

> *Our uncle has got spots where he goes to get pipi and tuatua from along the beach here* [Oneroa, Midway]. *He comes back with sackfuls.*

Also important topics for participants were the absence or decline of iconic indigenous bird and fish species, and the presence of a fungal-like discolouration on the shells of the crayfish (koura, *Jasus lalandei*). A further strong theme amongst participants was the desire for better and more open communication about the risks associated with harvest and consumption of kai moana from the rivers and Bay.

There were heaps of people at the beach gathering the shellfish. I wouldn't touch them. There should have been signs up telling that the waters were contaminated.

Turanganui a Kiwa Water Quality Enhancement Project

The Turanganui a Kiwa Water Quality Enhancement Project (TAK project) was established by the 2009 wastewater resource consent to provide a vehicle for the integrated research, monitoring, planning and specific projects that will aim to improve the mauri and the water quality of Turanganui A Kiwa (Resource Consent Decision, 2009, Clauses 18 and 19). Given the overall concerns relating to water quality in both the Bay and the rivers, and the expressed understanding of the effects of catchment land management as well as wastewater management on this, it is consistent that 69% of 88 survey respondents indicated that the Turanganui a Kiwa Water Quality Enhancement Project was Extremely Important, 18% indicated it as Very Important and 8% Important, while 2% believed it was Quite Important and 2% believed it was Not Important (Question 20).

Question 21 of the survey questionnaire asked *Would you like to be part of the Turanganui a Kiwa Water Quality Enhancement Project? Do you have any ideas on how such improvements might be made?* By December 15th 33 of the 88 respondents wished to be involved.

It would be an honour and privilege to be a part of the Team.

Yes, I would love to be part of this project.

Respondents provided a cross section of suggestions as to how improvements might be made including improved farming practices and better control of chemical and fertiliser inputs into waterways.

The rivers, from the head waters, need to be treated properly and landowners need to take more responsibility to manage run off which includes fecal coliforms from pastoral farming and sediment.

In this context, some participants felt that there needed to be greater accountability from agricultural industries in the district. A range of practical opportunities were also identified for improving our wastewater management:

Increase the use of sewage as a biofuel, and treated to level where it can be used as compost/fertiliser in suitable areas. eg in Tasman-Nelson they use it for pine forests on the Coast which has increased the forest productivity and at the same time disposed of sewage effectively and more appropriately, and improved water quality. Also a community action & education campaign, designed and led by the community and by Iwi (not GDC officials). Create opportunities for community energy and business energy to be innovative and achieve more wins.

Community participation was also again a strong theme:

> *Regular water testing, daily interactive communication with water users & GDC, & Community participation & contribution with festivals, Gala's, etc to obtain the required financial backing & funding to facilitate the well-being of the beaches & environment.*

Management of the whole wastewater process

At December 15th only 67% of 92 questionnaire respondents were aware of the new wastewater system set up to treat Gisborne's municipal wastewater (Questionnaire question 15), while 33%, were not. This lack of awareness was even more evident from the 60 visitors to the information display at the A&P Show, few of whom knew of the existence, location or type of system of the BTF plant, while none were aware that the new treatment system was part of a wider ongoing process to upgrade and ultimately remove the discharge from the Bay, or of the operation of the WTAG.

The first theme in relation to wastewater management amongst water users and survey questionnaire participants, however, reflected the problems associated with the delivery of sewage to the new plant, including overloading of the system through direct discharge of stormwater to the sewers, and infiltration via old, seeping infrastructure and damaged pipework, as well as the pressure from new subdivisions.

> *Oldest of failing pipe system to be replaced with complete system overhaul before 2025.*

A second theme involved an understanding that cultural practices can strongly determine waste management scenarios, and pointed to the opportunities for synergies between traditional indigenous cultural practices and beliefs and contemporary science.

The third theme was simply that we need to look at ways of not discharging contaminants into the sea. Looking to tried and tested techniques, what others are doing, and seeking good technical and cultural advice were suggested by questionnaire respondents alongside exploring new, practical ideas. This included having an updated and up-skilled strategic team, and more iwi and hapu involvement.

> *GDC needs to make it a priority to restore us to a more pristine environment by prioritising fixing up failing infrastructure, community-led education and action groups, innovative businesses to develop alternative uses for sewage, and being more honest and transparent with the public.*

Several participants pointed to the need to encompass the wider waste inputs, such as diffuse run-off from land, stormwater management, as well as the sewage overflows and current treatment processes. Overall, at December 15th 2013, of 88 respondents to Question 25, *How important do you feel the management of our*

sewage wastewater is to the community? 65% indicated that they felt the management of our sewage wastewater is Extremely Important. 27% felt it was Very Important, 5.7% Important, 1.6 % for both Quite Important and Not Important.

Numerous respondents to Question 27, *Do you have any ideas on how the current management of wastewater could be improved*, made specific suggestions, including more through-land treatment, the promotion of self-sufficient, decentralized waste treatment systems, and the encouragement of composting and alternative toilets and vermiculture. The utilization of our waste as a resource was a common theme, and suggestions were made for creating biofuel, compost, and water for reuse.

Some people referred to achievements made since 2011 through the establishment of the new BTF system, and recommended continuing to deal with the issue in a balanced and affordable way. This perspective was qualified, however, by many respondents.

> *Compared to the later 1980's until 2010 the improvement is noticeable and good. However, you have asked me to rate our current management not looking back….any raw effluent disposal into any waterway around a population is appalling.*

This was reflected in the 88 responses to Question 26, *How would you rate the current management of the district's sewage wastewater?* 52% rating it as Poor, 27% as Satisfactory, 16% as Good, 2% Very Good, and 2% Excellent. This was endorsed by statements referring to the need for more emphasis on keeping Gisborne clean and healthy for the future generations.

Communication and participation

The importance of good communication and genuine participation opportunities were strongly expressed themes across all participant groups in our survey. Generally, there is a perception amongst water users and the wider public that the people are not well informed about the way the whole wastewater management system works, including both the treatment and disposal systems, and the effects on the receiving environments. What was clear from all participants, however, was that they do want to know what's actually happening. One participant felt that there should be a community representative on the WTAG, while another pointed out that with 2000 registered waka paddlers in Turanganui a Kiwa, communication should be more face to face.

> *Just want to know what's going on! The community should be better informed on where whole wastewater situation is at.*

Participants were clear and measured in their discussions, stating that there needs to be better education, adequate warning systems, and the involvement of water users themselves in helping formulate notification and information processes, with the

goal of protecting community health and well-being. The August discharges to the city' rivers reinforced the perception of a deficiency of the current processes.

> *I give a 3 x per day radio surf report on 2 stations and during the recent overflow I was reporting that the surf was really good at the town beaches on the Monday and Tuesday. That Tuesday night was the first public notification of the overflow and that was 2 days after the discharge.*
>
> *I think that information about the discharge into the Bay should be more consistent and communicated better to the public. There should also be better signage about possible public hazards such as contaminated seafood.*

Comments from participants in our survey were unanimously positive, however, about being provided with the opportunity to participate.

> *I am very keen to have the surveys, info stands etc. in my shop, and excited that community is being asked to participate!*
>
> *Buzzing that community being asked for input, involvement.*

A practical example of participants' willingness to become involved was evident when asked whether they would limit using chemicals and other materials that might be harmful to the environment when discharged through the wastewater treatment process, 99% of the 94 respondents answered that they would. Similarly, when asked if they would encourage others to also limit their use of these, 95% of the 88 respondents also stated that they would. By December 10th, 23 of the 110 respondents to the survey questionnaire wished to participate in ongoing forums relating to our rivers and the coastal environment, and provided their contact details for this purpose.

Upgrade of the sewerage system

There was a clear desire amongst the representatives for an understanding of the options for sewerage system improvement, and the problems inherent in water based systems. Overall, however, it was believed that with current system in place, it would be good for any further treatment options to have low energy and cost requirements, and that could retrieve at least some of the nutrients, lipids, and organic matter in the waste, hopefully providing a compensating income stream, rather than simply disposing of the sewage material to waste at high cost.

With considered additional treatment steps to enable reuse of effluent solids and liquids. Seeing the sewage as an asset to be managed is an approach to consider. The water has reuse values that are lost when it is run to sea. The solids can be converted to reusable bio solids.

One participant suggested dispersed treatment systems, that is, simpler plants earlier in each arm of the system combined with natural wetlands. Wider issues such as agricultural run-off and industrial discharges were also referred to, with emphasis on a greater need for accountability from these sectors in reducing the impacts on the rivers and the Bay. The sewage overflows to the rivers and the Bay were also seen as components of this wider picture and, in light of the information about discharges and overflows during high rainfall events, representatives agreed that money should be directed to upgrading pipes and improving the wastewater delivery system.

There is a reality that our infrastructure needs upgrade. That will take time and resources. The objective to remove sewage from the outfall means every effort to tidy up, as best we can, the current use of scour valves is an important and priority task. The reality the rivers carry high levels of coliforms from animals does not mean the sewage overflows can be condoned. It does mean the land managers up stream need to lift the game and reduce/manage run off better.

There appeared to be a consensus that wastewater treatment is a vital part of our society, and that we need to give it a high funding priority. In response to Question 19, *The current consent to discharge treated wastewater to the Bay requires Gisborne District Council to find feasible ways to progressively remove treated human sewage from the ocean discharge, with the objective of complete removal by 2020. Do you have any ideas about how this might occur?* the dominant response was that we shouldn't be putting our wastewater into waterways in the first place. A corollary to this was strong support for land based treatment systems, and numerous questionnaire respondents described irrigation of forest crops, and other non-food producing uses for the liquid component of the waste, with energy generation and composting as options for the biosolids. Oxidation, settling ponds and fish farming were identified as possible further treatment methods.

One local shareholder in family land commented that her whanau had always wondered why some of their land wasn't proposed for oxidisation ponds, and seemed supportive of the idea. On being shown information about, and discussing the Organica food chain reactor urban wastewater treatment process, another visitor suggested:

Wow! That's a wicked objective! Lets' create a beautiful environment of filtering plants and organisms that could also be a visitable habitat...

The Bay is an integral part of our lives

The importance of the ocean, beaches and rivers to the water user groups and their representatives was clear and unanimous, namely, that water-based activities and the coastal environment are key activities in our region, both for locals and visitors alike.

> *The council should clean up their shit, it's been going on for years and years and I think we're just pretty much over it. Yea, they need to realize that that is our livelihood.*

Further, it was made evident that there are world class athletes here who use the rivers and Bay to train all year round, and given the high value placed on the coastal environment for recreation and tourism, including the brands Gisborne, East, Te Tairawhiti, proper waste management was perceived as an investment in the region, and should be treated as such, protecting and enhancing our critical assets.

At 22nd October 2013, when we initially assessed the responses to our survey questionnaire, 97% of the 67 respondents used the Bay or rivermouths for primary contact and secondary contact recreation and fishing or kai gathering. By the end of December, of the 114 respondents, 98 % used these environments for these activities. 64% of these respondents said they had been involved in these activities for greater than 15 years. When questioned about the frequency of this usage, 34% respondents said they did this greater than 10 times per month. This was slightly higher for primary contact recreational users, at 36%. In contrast, 36% of participants fishing and gathering kaimoana did so three or less times per month, although 11% did so more than ten times per month.

Biotransformation of the waters of Te Moananui o Turanganui a Kiwa

It may be that we can consider the level of biotransformation of the Gisborne Turanganui wastewater discharge in terms of the reduction in levels of contaminants such as *Enterococci* and other faecal-derived microorganisms, suspended solids and oil and grease, and apparent improvements in the microbial quality of the receiving waters surrounding and adjacent to the outfall. If this as accepted as an initial, if ultimately insufficient approach, and these findings are compared alongside the experiences and perceptions of water users in the Bay, it is evident that there are consistent parallels between the two sets of information in relation to current levels of biotransformation of our municipal wastewater streams.

These parallels include a sense that, while water quality may have improved in the Bay, this is not always the case, and climatic conditions including rainfall and wind and swell direction may mitigate against this. Certainly, at present, any improvement seems insufficient to enable the return of many recreational water users and kai gatherers to the Bay, and by far the majority of water users retain a perception of the management of our wastewater as poor. Similarly, and this also appears consistent with the monitoring data available, major concerns are held by water users regarding river water quality.

The almost unanimous perception amongst the primary contact water user participants in our survey, however, is that the continuing wastewater management system, including the delivery of wastewater to the BTF plant, is unacceptable, and the discharge needs to be significantly upgraded or preferably removed from the waters of the Bay entirely, in favour of reuse and recycle options for both the solid and liquid components. This perception is reinforced by the experiences of water users relating to the health risks of using the waters of the Bay and city' rivers, and the lack of sufficient epidemiological data or targeted water quality monitoring to indicate otherwise.

In such a context, a marked improvement in the quality of the ocean discharge, or removal of the discharge in favour of a land based system, alongside specific evidence of the absence of human pathogens and other contaminants derived from sewage in the rivers and the Bay, might be expected to see the return of contact recreational water users and kai gatherers, providing an indication of the extent of biotransformation achieved.

Nevertheless, there is a widespread understanding among the participants who participated in our survey that there are wider river catchment issues impacting on water quality in Gisborne Te Turanganui a Kiwa. These have been identified as including urban stormwater, agricultural land use impacts, and industrial and sewage discharges. Positioning the perceptions relating to the wastewater discharge in this broader context, it is the suggestion of this report that it may be of value to consider a more encompassing or holistic concept of biotransformation, if we are to meet community aspirations for improved water quality and the restoration of the mauri of the waters of Te Turanganui a Kiwa.

That is, in the current social and statutory context (including the 2009 GDC wastewater consent, the 2010 NZ Coastal Policy Statement, the amended 2011 NZ National Policy Statement for Freshwater Management and the proposed Gisborne Freshwater Plan) we might consider a focus on the biotransformation of the coastal

and river delta environment, Te Moananui o Turanganui a Kiwa, as a whole spatial unit.

Thus, the more extensive return of kai gatherers and contact recreational water users, alongside other key indicators (such as, for instance, phytoplankton assemblages, benthic invertebrates, iconic fish and bird species) and scientific assessments of ecological and public health, could suggest that the biotransformation of the wider Te Turanganui a Kiwa landscape was being achieved, and the mauri returning to good health, mauri ora.

Effecting the biotransformation of the wastewater discharge thus becomes a component of this wider landscape biotransformation. It may be that to effectively treat the oceanic discharge to a level to enable the return of key indicators will require a significant financial input from the community. However, the 2009 Consent requires removal of the discharge from the Bay as soon as possible (2020) and there appears to be strong community support for this. Thus, the level of biotransformation required to make the wastewater safe for receiving environments other than the Bay (e.g. discharging to a series of wetlands prior to land disposal or reuse) may provide for the biotransformation of the waters of the Bay in a more socially and culturally acceptable, and cost effective manner.

Biotransformation may thus be viewed as *the transformation of a landscape or setting through the application of scientific and cultural understanding and knowledge, such that the indigenous resources of that landscape or setting become available for the safe and ongoing use by the community*. Such a definition could include the specific transformation of a particular wastewater flow (e.g. post Gisborne wastewater treatment systems), and alongside the myriad of other contexts to which the word gives meaning.

Recommendations

Background

Areas of importance that emerged throughout our survey as key foci for the participants, can be summarised as the following:

- The critical importance of appropriate health risk assessments being made of the levels of treatment and endpoint of any wastewater discharges, including the current system;
- More rigorous monitoring and assessment programs for water quality and associated public health threats, including wider, whole catchment issues;
- Identification of the inter-relationships between cultural wellbeing, public and ecological health, and the appropriate management of our waste;

- Greater opportunities for public information sharing, communication of options for wastewater system improvements, education, and community participation;
- The importance of our riverine and coastal environments to the Gisborne Te Tairawhiti community across a wide range of values and for a wide range of activities and resources, including contact recreation, kaimoana gathering, and the potential for enhancement of these and commercial fishing opportunities;
- The significance of these environments to key industries such as tourism and food production, and the overall way our region is perceived by ourselves and others (e.g. 'brand' East, Gisborne, Te Tairawhiti);
- A reviewed assessment of priority funding for infrastructure works, given the significance attached to wastewater management in general and, in particular, the discharge of raw sewage during high rainfall events.

Taking these factors into account, this report anticipates that the overall social components survey, when complete, will positively and in detail inform decisions around wastewater management in terms of the effluent improvements required, alternative use and disposal options, and ongoing monitoring and participatory processes. Building on the current social components of the biotransformation of wastewater research findings, however, and aiming to help facilitate such a decision making process, this report outlines some specific recommendations to WTAG for implementation prior to final decisions around further treatment system components and the alternative use and disposal of the districts wastewater.

Recommendations

1. The establishment of a water user liason group to provide input directly into GDC's communication and information sharing processes and ongoing discussions relating to wastewater management;
2. The inclusion of contact recreational water users' representatives on the WTAG or any similar body;
3. The establishment of a community group, based initially on the questionnaire respondents who registered as keen to participate at a greater level in discussions and projects around wastewater and coastal and river catchment management, and facilitated under the umbrella of the Turanganui a Kiwa Water Quality Enhancement Project (likely to also become a part of a liason group as above);
4. Review of our recreational water quality and shellfish gathering monitoring systems, with a view to assessment of those areas and periods when 'at risk' behaviour is likely to occur, such as for instance, just after a southerly or easterly blow, and in the surf zone beyond the breaking waves;

5. Monitoring of city river sediments to understand potential levels of residual contaminants including pathogenic microorganisms, heavy metals, hydrocarbons, etc.
6. Targeted monitoring of shellfish for similar parameters;
7. In liason with water user groups, the establishment of specific epidemiological studies and database of health risks associated with contact recreational water use and the consumption of kaimoana from the Bay and riverine environments;

8. Establishment of an effective process of establishing priority actions for wastewater management programs, inclusive of further treatment options, alternative use and disposal options, and improvements to the sewerage infrastructure to minimise emergency discharges; engagement with water users and the wider community about this work;
9. Complete the *Social components of the biotransformation of wastewater* research project proposal, including an updated assessment of the values attached to the Bay and associated river environments, options for wastewater treatment upgrades and alternative use and disposal programs (including establishment and running costs), an overview of the statutory context for improved wastewater management in our district, and a public survey of preferred options;
10. Consider the concept of biotransformation at a landscape scale, i.e. the transformation of a landscape or setting through the application of scientific and cultural understanding and knowledge such that the resources of that landscape or setting become available for the safe and beneficial use by the community.

Background

Gisborne wastewater resource consent decision 2009

In December 1964, an outfall pipe was installed transporting Gisborne City's untreated wastewater 1800 metres out into the coastal embayment, Te Moana o Turanganui a Kiwa (the Bay). Apart from the introduction of a milli-screening plant in 1990, this system of wastewater disposal, despite being the subject of significant debate and challenge, was to continue for 45 years until early January 2011.

In June 2009, consents were finally granted for the development of a new wastewater treatment plant for Gisborne city's municipal sewage. A major driver for

the new system was to provide for tangata whenua and the wider community's values and interests in the coastal environment of the Bay. The independent commissioners hearing the consent applications by Gisborne District Council (GDC) made clear:

> *The effects on tangata whenua from the existing wastewater arrangements at Gisborne and the upgrade proposals has been a paramount consideration. It has been made very clear at all times, and over many years now, that the continued discharge of untreated wastewater to the waters of Poverty Bay violates Maori tikanga and is a major effect on the cultural and spiritual sensitivities of tangata whenua. A key component of the on-going action to implement an improved wastewater treatment scheme is the input from tangata whenua, in partnership with the other interested parties* …. (Watson *et al*, 2009, p27).

The proposed 2009 system, however, embodied significant alterations from an earlier agreed program granted consent in 2007, ostensibly due to the anticipated high costs associated with the 2007 consented proposals. These 2009 changes were agreed to in a consensual process amongst all participants, including the tangata whenua appellants, and included:

- A single Biological Trickling Filter (BTF) plant (loaded at a higher rate of BOD/m^3 of media/day) instead of the initially proposed two BTF plants, and followed by effluent clarification and disinfection;
- The proposed location for the treatment Plant moved from Aerodrome Rd to 31 Banks Street, a site within the Gisborne City Industrial Subdivision and approximately six kilometres closer to the discharge outfall infrastructure.

Further, a series of other compensatory conditions were added to the 2009 consents including:

- The proposal for a BTF Plant Monitoring and Investigation Study that will determine the need (or otherwise) for further treatment processes to be scheduled;
- The formation of a Wastewater Technical Advisory Group (WTAG) that will, among other roles, oversee the initiation of the BTF Plant Monitoring and Investigation Study. (*Ibid*, Clause 4A);
- The implementation of the Turanganui a Kiwa Water Quality Enhancement Project, a vehicle for the integrated research, monitoring, planning and specific projects that will aim to improve the mauri and the water quality of Turanganui A Kiwa (*ibid,* Clause 19);
- The adoption of alternative use and disposal (AUD) options that are identified as feasible and which will enable the progressive removal of the treated human sewage from the discharge, via the marine outfall, with the objective of complete removal by 2020 (*ibid,* Clause 8).

These latter conditions are designed to assess if the reduced system will still be able to meet the objectives of the original 2007 consent, including the restoration of tangata whenua values for the moana (ocean), and provide for safe alternative use and disposal (AUD) by 2020 (*Ibid*, Clauses 5 and 8). Specifically, the monitoring and evaluation of the wastewater treatment system process and its effects (the BTF Study) will provide the basis for a set of recommendations, due December 2013, to the Gisborne District Council (as permit holder and consent authority) and to the Gisborne Wastewater Management Committee (comprising four district councillors and four iwi representatives and established to monitor the implementation of the Consent) in regard to the following. Sections relevant to the current social components project report are highlighted in bold type:

a) Summaries of monitoring results of the BTF Plant Monitoring and Investigation Study.

b) The extent of biotransformation being achieved by the BTF Plant.

c) Appropriate parameters and a monitoring program for ongoing assessment of biotransformation.

d) Appropriate parameter limits to ensure biotransformation is being achieved.

e) Review of existing permit conditions: 37, 42 and 43 and recommend any changes to these.

f) Recommend what additional treatment steps (if any) are required to achieve biotransformation and other requirements that may be necessary to improve the quality of the discharge to avoid adverse effects.

g) *In the event of the WTAG being unable to make a recommendation to the permit holder as per f) above, or the permit holder refusing to implement any recommendations as per f) above, then clause 37 and clause 43 shall take effect.*

Section g) above underpins the significance of the role of the current study. That is, if the WTAG are unable to agree as to the steps needed to achieve biotransformation and an improvement of the quality of the discharge, or if GDC is unwilling to implement recommendations regarding such improvement, then the 2009 Consent requires the discharge to meet the earlier 2007 Consent requirements for Total Oil and Grease and Suspended Solids (Clause 43) and that the Biological Oxygen Demand through the treatment plant does not exceed 0.4kg per cubic metre of BTF treatment media per day (Clause 37). In effect, it is anticipated that this could entail the construction of a second BTF plant structure at the current treatment site, at considerable expense.

The 2009 Consent states that the BTF Plant Monitoring and Investigation Study shall include the following. Again, sections relevant to the current social components research are highlighted in bold type.

(i) *Investigate the extent of biotransformation achieved by the Single BTF plant, including the disinfection plant once it is installed:*

a. Define biotransformation

b. Determine the relevance of BOD as a measure of biotransformation

c. Determine the relationship between Suspended Solids and biotransformation of wastewater

d. Determine through monitoring, data analysis and research relevant parameters to be used in assessing biotransformation

(ii) Investigate the extent of micro-organism reduction achieved by the BTF plant and wastewater disinfection plant.

(iii) Investigate through surveys, literature reviews and research the importance of social, cultural and environmental components of biotransformation in the treatment of wastewater.

(iv) Determine the relationship if any between the BTF plant BOD loading and micro- organism reduction.

(v) Investigate the relationship between wastewater treatment processes and their carbon footprint. (*ibid*, Clause 4A)

Biotransformation: towards a definition

A particular challenge facing the current social components of biotransformation in the treatment of wastewater research project is that the concept of biotransformation does not have one single definition, but is frequently used differently in different contexts. The United States Geological Survey, that nation's largest water, earth, and biological science and civilian mapping agency, lists five distinct definitions currently in use:

> *"Chemical conversion of a substance that is mediated by living organisms or enzyme preparations derived there from." (Stephenson et al, 2006)*
>
> *"Biotransformation is the process whereby a substance is changed from one chemical to another (transformed) by a chemical reaction within the body." (National Library of Medicine and Monosson, 2007)*
>
> *"The series of chemical reactions that occur in a compound, especially a drug, as a result of enzymatic or metabolic activities by a living organism." (McGraw-Hill Companies, 2003)*
>
> *"Chemical alteration of a substance within the body, as by the action of enzymes." (Editors of the American Heritage Dictionaries, 2000)*
>
> *"The use of living organisms to modify substances that are not normally used for growth." (Prescott et al, 2002)*

http://toxics.usgs.gov/definitions/biotransformation.html retrieved 8.10am 11.4.2013

The treatment of sewage or other wastewaters with biological trickling filters is among the oldest and most well characterized of wastewater treatment technologies, the removal of pollutants from the wastewater stream involving both absorption and adsorption of organic compounds by a layer of microbial biofilm. In the context of wastewater treatment, and specifically the biological trickling filter currently in place in Gisborne, Leonard provides a description of the transformative process within the BTF plant:

> *In a trickling filter the micro-organisms in the biofilm metabolise the biodegradable component of the dissolved and particulate contaminants in sewage. This process provides the carbon and nutrients necessary for microbial cell growth. Other microorganisms then use the micro-organism cells as their food source, and in turn become a food source for organisms higher up the food chain.* (Leonard 2009, p2)

Despite this level of detail, difficulties remain in defining biotransformation in the Gisborne Te Turanganui context. These are centred around the need, identified at successive WTAG meetings during 2012, for the development of a Maori cultural perspective as to what constitutes biotransformation, such that, for instance, when might water that has been degraded to the point of being dangerous for human use (waimate) become proximate to water suitable for common human uses such as drinking, food gathering and bathing (waimaori) (Durie, 1998), and what processes might be acceptable in order to achieve this. Further, it was made clear any definition would need to be able to be understood and assessed by non-specialist members of the community. Assigned the task of addressing such difficulties, Dr Amber Dunn suggested the following:

> [Biotransformation is] *A biological process – by living organisms – which remove and/or breakdown harmful contaminants in effluent into safe, non-toxic components that can by cycled back into the environment* (Dunn, 2009).

This definition, however, was not fully endorsed in the WTAG forum, and the question of developing a useful and consistent definition of biotransformation was set to one side, while a series of research projects deemed relevant were initiated with the intention of establishing robust data providing for a satisfactory definition (or set of definitions) and an evaluation of the new wastewater system against this/these. It is anticipated that the current project outlining the social components of the Gisborne BTF wastewater treatment process and other projects investigating the ecology, including the DNA ecology of the process, and the chemical components in the effluent will contribute to an improved understanding of biotransformation in the context of the treatment of municipal sewage.

Social components in the biotransformation of wastewater

Nor is there a definition in the 2009 Consent Decision as to what factors specifically constitute the 'social components in the biotransformation of wastewater'. In the WTAG report *2010 Social Evaluation: Base Line Data*, a series of categories were identified that could be seen as providing an initial context for investigating the importance of such social components. These categories were:

1. Social economy and recreation
    a. Costs and economic benefits associated with wastewater treatment and disposal
    b. Recreation
    c. Tourism
    d. Education
2. Resource harvesting
    a. Fishing
    b. Shellfish gathering
3. Health and wellbeing
    a. Contact and secondary contact recreation
    b. Shellfish gathering

The activities as carried out in the Bay environment can be seen as closely linked to water quality here. The current research project looks to provide:

- A survey of the notifiable disease records from the Institute of Environment and Science Research (ESR), and other sources where available, to assess any identifiable patterns of change in reporting of the types of disease commonly associated with poor water quality;
- A targeted and detailed discussion and questionnaire survey of water users and their group representatives, who carry out their activities in the Bay environment on a regular basis, and including their experiences, perceptions and aspirations for the takutai moana (coastal marine environment) and associated river systems;
- Open discussions occurring during public events (the A&P Show and the Tairawhiti Environment Conference) and a questionnaire survey gathered from the *He Awa Ora, He Tai Ora, Healthy Rivers, Living Sea* Facebook page, including the wider community, who may have lesser levels of interaction with the coastal environment, but nevertheless can provide relevant experiences and reflections on water quality and the social contexts in which wastewater treatment occurs.

Further, discussions within the Social Components of Wastewater Treatment project team, alongside the collective WTAG experience of the functioning of the BTF plant to date, have indicated two further significant social components to the treatment of wastewater in the Gisborne context that need to be signposted and reported on. These are:

- The restoration of a level of trust and recognition of Te Tiriti responsibilities amongst the tangata whenua of Te Turanganui a Kiwa, GDC, and the wider community;
- Indications that public education and community participation in the wastewater treatment process may assist in providing for an improved level of biotransformation. This could, for example, be through educational initiatives that include:
    - A wider understanding of the potential effects of what we use and dispose of through the system, such as surfactants, antibiotics and other chemicals;
    - A realisation that it is a community responsibility to police activities such as the illegal disposal of toxic wastes through the system;
    - The development of specific education programs looking at wastewater management, alternative management and use scenarios (the AUD Project), and the restoration of the water quality and mauri of the waters of Te Turanganui a Kiwa (TAK Project).

Other strands of work from the WTAG group that this report will be included alongside are:

- A cultural analysis of biotransformation and the mauri of the Bay environments;
- A review of the current wastewater treatment plant and receiving environment monitoring data, and an assessment of the relevance of the existing monitoring methodology and parameters;
- Analysis of the biological composition of the wastewater treatment process and effluent stream;
- Analysis of the ecology and trophic functioning of the BTF plant;
- A survey of new and emerging chemicals in our waste stream and the ability of the BTF process to 'biotransform' these;
- Options for utilisation of the sludge and solids from the wastewater treatment process;
- Investigating the options for constructed wetlands for tertiary effluent processing;
- A broad survey of the options for alternative use and disposal of our municipal wastewater.

An important event affecting the implementation of the social components research project, and confounding the nature of the responses from participants, was the intentional discharge of raw sewage to the Taruheru and Turanganui Rivers to protect against back-flowing in the system on August 11th and 12th 2013, after several days of heavy rainfall.

This event coincided with the drift cast onto the shore at Waikanae and Midway (Oneroa) beaches of thousands of bivalve shellfish of the species tuatua, tuangi (cockles), blue and green mussels, and surf clams (*Mactra sp*), all of which are highly prized kaimoana species. Unfortunately, it appears that notification of the discharge did not adequately reach the water users, waka paddlers, surfers, and the many people who assembled at the beaches to gather the drift cast shellfish and subsequently consume these.

Understandably, the discussions in our interviews and focus group meetings, and responses to our survey questionnaire reflect this event and other perceptions relating to the role of the rivers in water quality in the Bay. Hence, the importance of these rivers to recreational water users features strongly in the participants' statements. In order to attempt to delineate the very real issues associated with the overflows that occur to the rivers and ocean during high rainfall events from the wider assessment of the functioning of the BTF plant, we included specific discussion and survey questions relating to river water quality, and the effects of such overflow discharges.

Despite such a delineation, however, the rivers, delta areas, and the Bay itself are an integrated and coherent functioning ecological system, and the recent overflows, and the issues, questions and discussions that they have brought to light, can be anticipated to help inform an improved integrated management of the wider ongoing wastewater treatment processes and programs.

Research design

Purpose

The primary purpose of the current Social Components of Wastewater Turanga Gisborne research project is to provide an analysis of the social components of biotransformation in the treatment of Gisborne's municipal wastewater, particularly in the context of the three years since commissioning of the plant at the beginning of 2011. This is a requirement embodied in Clause 4A (iii) of the 2009 Resource Consent Decision, namely to:

> *Investigate through surveys, literature reviews and research the importance of social, cultural and environmental components of biotransformation in the treatment of wastewater.*

In the wider context of Clause 4A of the consent conditions, this research project is anticipated to further inform:

- *A definition of biotransformation and the extent of biotransformation being achieved by the BTF Plant;*
- *Appropriate parameters and a monitoring programme for ongoing assessment of biotransformation;*
- *What additional treatment steps (if any) are required to achieve biotransformation and other requirements that may be necessary to improve the quality of the discharge to avoid adverse effects* (Resource Consent, Clause 4A).

Research method

In order to make a delineation between the experiences and aspirations of Bay water users and the wider community, initial engagement was with key individuals or representatives of the main water user groups, and then with members of the groups themselves from the Bay environment. These individual and groups are identified in Table 1 below. From here, opportunities were provided for the wider community to input via an information stand at the A&P Show in Gisborne over Friday 18th and Saturday 19th October, a one day Tairawhiti Environment Expo, and through the survey questionnaire.

A total of 19 representatives from primary recreational water user groups (surfers, surf lifesavers, paddlers, swimmers), secondary contact (boating, port activities) water user groups and local kaimoana (seafood) gatherers, were interviewed between mid-September and mid-October. These interviews were with individuals who have significant recognised experience, or who occupied an elected position in their fields. Approximately 50% of these recreational water users were currently, or who had been, kaimoana gatherers in the Bay also.

Initially, the survey plan anticipated discussions to be conducted with eight discrete water user focus groups after initial interviews with their group representatives. This was amended after consultation in the October WTAG hui, with a more flexible approach involving some formal discussion groups alongside a series of informal, opportunistic discussions with groups of surfers and paddlers at the venues of their activities, namely the rivers and the beach. This approach proved to be effective, with a dozen individual group discussions involving approximately seventy participants. As elsewhere, the responses from participants are grouped under key theme headings.

Table 1	Water user groups and representatives	
Activity	*Scope of use*	*Representative*
Surfing	Regular primary contact recreational water users highly 'at risk'; immediate experience of water quality	Don Pearson Tommy Swann Joe Palmer Nikki Rawls
Surf lifesaving	Regular primary contact recreational water users highly 'at risk'; immediate experience of water quality	Rocky Hall Gary Stevens Matt Sutton
Waka ama Kayak	Regular primary/secondary contact recreational water users highly 'at risk'; immediate experience of water quality	Matahi and Raipoia Whakataka-Brightwell Bub Apelu Keiha Waikari Peter Boyd Jason Love Alan Thomson
Kaimoana gathering	Potentially the most 'at risk' population from poor coastal water quality; experience of water quality and of possible changes in coastal resources	There was no single representative, as this group is not viewed as a distinct entity
Recreational fishing	Their experience of water quality and of possible changes in coastal resources	Roger Faber
Commercial fishers	Experience of water quality and of possible changes in coastal resources	Gordon Halley Darryl Moleta
Bay boating community	Experience of water quality	Glenn Watt
Health professionals	May have experience of gastrointestinal disorders amongst local population; several also surfers	Brian Gibson

Details of the activities undertaken as components of the overall research are outlined in Appendix 1 below. Key staff and supporting individuals in the project are identified in Table 3 below.

Table 2	Key research project participants and support
CMT Champion	Peter Higgs
Project sponsor	Dave Wilson
Project leader	Murray Palmer
Support team	Peter Williamson Gordon Jackman
Community assistants	Nikki Rawls Peter Boyd Renee Wikaire
Research reviewer	Dr Jennie Harre Hindmarsh Peter Williamson Gordon Jackman

Key topic areas

After discussions with individual representatives from the surf lifesaving, surfing, waka and kayak, recreational and commercial fishing, kai moana gathering, sailing and health sector communities, it became evident that the experiences, perceptions, and aspirations of these individuals, although at times differing in the weight attached to specific concerns, could be grouped under the following key topic headings.

- Water quality in the Bay
- Water quality in the rivers
- Kai moana resources
- Health risks associated with the use of the Bay for recreation and kai gathering
- Management of the wastewater system and potential upgrades
- Te Turanganui a Kiwa Water Quality Enhancement Project
- Communication and participation
- Recognition of the significance of the Bay and rivers to individuals and our community, an integral part of our lives

Further interviews and discussions amongst the focus group participants reinforced the usefulness of these headings, and they have been adopted in the collation and reporting of the individual and group responses, and the quantitative and qualitative material provided to us in the completed questionnaires.

Research questions

Key questions underpinning the purpose of the research are:

- To what extent are water users and the wider community satisfied with the current effluent discharge and water quality in the Bay, given the level of biotransformation achieved by the BTF process to date?
- To what extent do the quantitative elements of the data (treated effluent and receiving environment water quality analyses and associated health risk assessments) match the qualitative elements (coastal water users' and the wider community's experiences, perceptions and responses to the BTF treatment process)?
- If these elements do not match, what factors might need to be resolved, or further monitoring be required, to meet the needs of water users and/or the wider community and/or the consent holder?

Survey results

Water quality in the Bay

There was significant diversity amongst survey participants relating to the quality of the coastal marine waters of the Bay. The representative from the Tatapouri Fishing Club, for instance, had noted that since the BTF plant had been established, there have been no 'moans and groans' from fishers heading to farther waters about the quality of water in the Bay they were travelling through (including less sign of birds and fish feeding directly above the outfall). One experienced surf lifesaver was adamant that the outfall pipe and milliscreens had improved the discharge effects more than the recent treatment system has, and some water user representatives indicated that water quality in the Bay may generally be acceptable, although not after heavy rains.

While most were grateful that our sewage is at least being treated to some degree (compared to the discharges of raw faecal waste to the rivers), surfers tended to point out that water quality in the Bay is significantly different to coast beaches, and that fat globules are still present in the Bay waters. It was commented, however, that if the wind has been offshore for a few days, the water quality for surfing, swimming and paddling may be acceptable. One participant noted that he thought the Bay water was cleanest it had ever been.

Nevertheless, if the wind has been onshore and particularly associated with a heavy swell, the general understanding is that water quality will be poor due to the material from the sewer outfall being pushed onshore.

> *If the wind has been offshore for a few days the water quality is fine. If the wind has been onshore and a heavy swell, the water quality is poor due to the material from the sewer outfall being pushed onshore. This has been consistent for the 40 years I have been using the Bay beaches.*

An experienced waka coach gave a description of her crew's experience when the wind is blowing southerly and they are on a paddle into the Bay, describing how they pass through an effluent plume that smells distinctively of sewage, and is darker and oilier than the surrounding water.

> *When we pass through the plume out past the bouy, we rinse our arms and paddles in the cleaner seawater*.

Many of the focus group participants referred to the fact that they had stopped swimming or surfing in the Bay because of the water quality, some referring to a scum or film that formed on their surfboards, for instance. Many people told us that they only let their children swim and surf at Wainui, or the other coast beaches, because of concerns around contamination present at the town beaches.

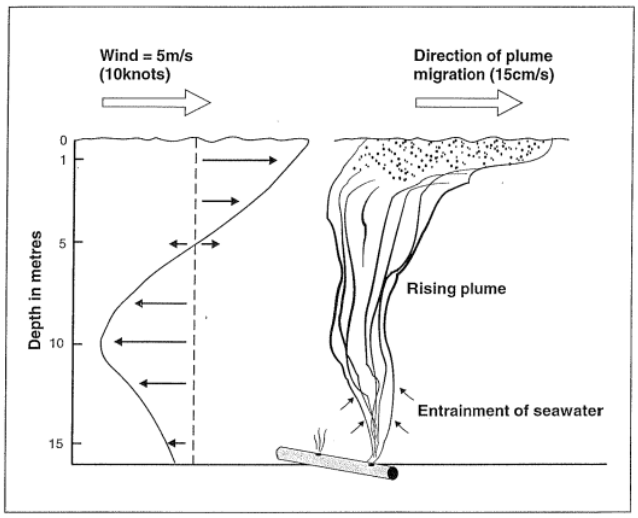


Diagram source: Stephens & Black

Typical current regime near to sewer outfall, sewage plume migration and entrainment of sea water.

> *I surf, however I tend to avoid it* [the Pipe surf break] *now due to the water quality*
>
> *Noticed brown stuff on the water line and scum. I have stopped surfing in the Bay because of the scum/film left on the deck of my boards*
>
> *Colour and smell, polluted*

Heavy rainfall (often associated with such onshore conditions) was also felt by the participants to be associated with lowered water quality. Over 60% of the survey questionnaire respondents said they had personal experience (or knew of people who had) of discharges of untreated sewage into the ocean and rivers during such periods of intense rainfall. When asked how harmful they felt these discharges are to either the people, culture, environment or economy, at October 19th, 61% of water users responded Extremely Harmful, 17% Very Harmful, 13% Harmful, and 4% for both Quite Harmful and Not Harmful categories. Responses including the wider community by the end of December were 49%, 21%, 21%, 6% and 3% respectively.

> [After the heavy rain in August 2013] *I really noticed the smell of the water was a thick aroma of rot and there was some discoloration of the water. The smell was the worst.*

When engaged in ongoing discussion, many participants echoed the sentiment:

> *It* [the sewage discharge into the Bay*] is disgusting. It's just out there and we're in it all the time.*

Questions 11, 13 and 16 asked for qualitative responses from participants in the survey questionnaire. These questions were:

> *Q11: Over time, and particularly over the last three years, have you noticed any differences in the quality of water in the Bay (eg colour, smell, oiliness, taste)?*
>
> *Q13: Over time, and particularly over the last three years, have you noticed any differences in the material on the beach or tide line?*
>
> *Q16: If [you are aware of the new wastewater treatment plant], given your experience as a coastal water user, do you think there's been an improvement in the waters of the Bay since January 2011?*

At October 19th, almost all of the 80 respondents answered question 11, however only 24 who answered 'yes', were clear as to whether the changes were for the better or worse. Of these 24, nineteen stated that the quality had improved, and five that it had become worse. Fifteen of the total respondents believed that overall there hadn't been any noticeable change. Of these, several identified that water quality in the Bay varies greatly depending on weather conditions, especially wind direction and strength. Some respondents felt that there are other significant influences on water quality confounding the situation, including harbor activities, stormwater, and upper catchment factors.

> *No, council is continuing to dump raw sewage and increased port activities can't be leading to an improvement!!*

This was referred to even when an improvement was noted.

> *Have noted improvement yet remain concerned over sediment which I feel is more to do with upper catchment than the sewage system.*

Respondents did, however, suggest that there is at times better water clarity (*you can see your own foot in the water at knee depth*), the smell is not as strong, and there is less evidence of a plume from the outfall.

Yes. Colour has improved. It's clearer. It is less slippery and oily. Taste seems to have improved though I don't make a habit of drinking it. It's definitely cleaner and more user friendly.

Some of those suggesting water quality had declined associated this with mud and debris in the rivers, on the beach and in the Bay. Respondents also suggested that initially there was an improvement *but now it seems worse.* Even when an improvement was noted, there was also frequent expression that the current disposal of sewage to the Bay wasn't good enough.

Feel so but aware that sea is still being used as part of the treatment and am not easy with that.

Water quality in the city rivers

The recreational fishing representative made a clear comment about the quality of water in the harbour, including major discolouration, and referred to the discharges from the log yard and port activities as being of real concern, and needing to be addressed. Consistent responses to the water quality in the city's rivers came from the waka paddlers' representatives, who are frequent users of the rivers during both summer and winter, and the surf lifesavers and kayakers who also train in the estuarine reaches of the Waimata, Taruheru and Turanganui Rivers.

Especially strongly expressed was opposition to the discharges of untreated sewage, but the effects of stormwater, sediment, debris and diffuse run off from upstream activities, were also commented on as significantly impacting on water quality.

Yea the water quality of the river is a huge concern to us as waka ama paddlers and it's something that raises its head as a topic both in our clubs and as club members. Individually we always talk about the rubbish and sewerage that's going in there.

We're one of the top voluntary organisations around and we're doing this for our people and we've got this barrier of the water quality.

One participant felt there had been a recent improvement, however.

My whanau swim in the Waimata river nearly every day in Summer when the tide is right. We have had more brown water during the more frequent freshes recently, coinciding with the high rainfall events. These events also change the colour of the sea, but I think the water quality particularly in the

Turanganui river mouth is in general better than in years past. I acknowledge the use of the river for council drainage overflow and would be very pleased if there was an alternative.

Issues around debris and litter along the Waikanae and Midway beaches was a common theme of discussions. Most felt there were increased levels of human and industrial waste, including farming materials, animal carcasses and driftwood, especially *Pinus radiata* forest harvest debris. One participant asked why GDC only appears to 'clean' the beaches for the summer influx of tourists.

The question of debris and other material, litter and sea scum, deposited on the beaches from the rivers was frequently, and strongly referred to also by respondents in the questionnaire, and catchment land management referred to in this context. Almost all participants responded to this question, with twenty eight clear that the situation had become worse and one that it had improved.

More rubbish and plastics. More logs and branches

Yes definitely compared to 40 years ago

Seems to be heaps more rubbish and drift-wood (as well as dodgy brown frothy scum).

The poor quality of the river water in the city was also a commonly reiterated theme amongst survey participants. Even where an improvement was noted, opposition to the use of the rivers as a discharge point for sewage was consistently made evident.

Don't go into the water after heavy rain. (don't take the waka out when too much paru mud). Can't use the waka at low tide because there is too much mud.

No we are fighting the erosion and storm water I would like to know if council are going to use the rivers as a means to flush sewers.

Health risks

Participants were generally aware that it is very hard if not impossible to categorically implicate sewage discharges in the Bay with specific illnesses without specific epidemiological studies of individuals and disease vectors and infection pathways. This perspective was reflected in the divergence of opinion amongst water user representatives around likely sources of health risk contamination in the Bay, although reference was made to a sense of something 'undesirable' about the waters, and continuing reports from water user group members of specific illnesses and concerns about being unwell related to using the waters of the Bay. This was often referred to as being particularly relevant after onshore winds or rain when the waters become discoloured.

The theme of rainfall increasing health risk was constantly reiterated by the representatives, with the most serious issue identified as the direct discharge of untreated sewage from the release stations into rivers, and from the treatment plant overflow out to the Bay during heavy rains. In these, and in general in relation to the management of health risks by primary contact water users, the avoidance of surfing or paddling after heavy rain, and avoiding contact with sediments as much as possible (e.g. by paddling only at high tides) were identified as key mitigation strategies. Nevertheless, surfers usually do take to the waters after storm events when the waves are at their best and potentially the risks highest, and paddlers do continue to train even when the waters are discoloured.

> *We know sometimes that there's a risk paddling especially when the river is discoloured, but it's our sport, our life.*

Three further factors were identified by the representative participants. The first was a concern expressed by three separate water user spokespersons of the potential for serious health effects if a major influx of visitors in summer is associated with an intense rain event.

> *I think it sucks, I think that people should be told about it, instead of making these excuses and just doing it. Because the beaches are what the people come here for, especially in summer so what's going to happen when we have downpours in summer then what is the GDC going to do? … I just think it is disgusting.*

Secondly, the questions of environmental monitoring and health assessment were identified as important considerations to be addressed. Fortnightly water quality monitoring was believed to be insufficient for this, alongside a need for specific testing of river and marine sediments. A further important consideration was the opportunity to develop specific epidemiological studies to assess health impacts of water use in the rivers and the Bay.

Thirdly, recognition of the role of Maori cultural concepts of well-being, combining physical, spiritual and metaphysical elements, was expressed as an important component in the development of a precautionary approach to managing the health risks of wastewater management, both for local community members and visitors alike.

Although many focus group participants said they would not harvest kaimoana from the Bay, particularly bivalve shellfish, they acknowledged that many people do, and comments relating to the recent river discharge even (August 11th and 12th 2013) were consistent.

> *Yes, gathered kaimoana and took the kai to a tangi and a few people got sick. Also work friends got sick too.*

Primary contact recreational water users also report significant adverse health effects. Often, these are believed to be associated with heavy rain or known sewage discharges. Residual effects are also said to be derived from the river and delta sediments.

In order to get a wider sense of exposure to health risks, and water users' perceptions of these, Question 14 asked the participants, *Over time, and particularly over the last three years, have you noticed any differences in the numbers of people you know who might have become ill after swimming or surfing in the Bay, gathering seafood etc?* In response to this question at October 19th 2013, almost all 80 water user respondents answered, twenty two (28%) stating that they did know of people who had become ill, including themselves, and this seemed to have increased over the last three years. At the end of December 2013, 37% of the 93 who answered this question gave similar responses. Several gave figures of five to ten individuals they knew of who had been affected after a particular day or incident.

These experiences were strongly linked to the river discharges that occurred in August 2013. Numerous other respondents, particularly those with long term association with the waters of the Bay and Te Tairawhiti, acknowledged that they believed there was a health risk associated with surfing at the town beaches, and had subsequently adapted their behavior accordingly.

> *I won't let the groms' surf pipe which is a shame as it is a great learner break. Aptly named the Pipe indeed?*
>
> *Have always known people to get sick at some stage after surfing in the bay*
>
> *I have heard of people feeling ill after entering the water. My own family don't use the bay so I can't comment in any detail*
>
> *Several of the guys who surfed on poopy Monday last month were still ill in bed that following week according to facebook.*
>
> *Yes waka ama whanau noticing scabs, people got sick after eating the pipi in August.*

When asked to describe specific experiences of untreated sewage overflows and discharges (Question 23), of the 50 people who answered that they had experience of such events, 45 gave details.

> *The very last discharge that was made I surfed at Pipe 2 days after I heard on the radio about the discharge. I really noticed the smell of the water was a thick aroma of rot and there was some discoloration of the water. The smell was the worst.*

A common theme amongst participants was the need for an integrated approach to management of the contaminants entering our river and coastal environments.

There is a reality that our infrastructure needs an upgrade. That will take time and resources. The objective to remove sewage from the outfall means every effort to tidy up, as best we can, the current use of our valves is an important and priority task. The reality that the rivers carry high levels of coliforms from animals does not mean the sewage overflows can be condoned. It does mean the land managers up stream need to lift the game and reduce/manage run off better.

Kai moana resources

Currently, the only commercial fisheries in the Bay are for flounder and crayfish (with a total of three fishery quota holders), although there are a range of other species with commercial potential (eg Tua tua, *Paphies subtriangulata*; *Mactra* species). There are, however, a wide range of species collected by recreational and customary kai gatherers.

In general, the commercial fishing representatives felt that there are wider ecological and environmental factors than simply the wastewater discharge implicated in the abundance of their fisheries. Others with experience of the wider resource base, indicated a decline in the abundance of certain species, including freshwater eels (Tuna, *Anguilla sp.*) and mullet (kanae, *Mugil cephalus*) and their quality.

Focus group participants referred to a wide range of characteristics of the kaimoana resources present or absent in the Bay environment. One participant noted that during last summer (2012/13) there were very few fish-diving birds and kahawai, and fewer dolphins compared to previous years. In contrast, another participant noted there were more craypots present and crayfish taken last summer from the reefs in the Bay, while another stated that fewer koura (crayfish) were evident, and the ones that are there are often very discoloured with a black fungus-like mould on their shells.

Participants spoke of the high sediment levels in the water, and more frequent drift casts of shellfish. Most, however, referred to the contamination of shellfish beds, and the removal of the resource from human consumptive purposes.

Everything from the Island to Kaiti beach is not edible - as a young boy that was our kai moana grounds to gather for dinner.

I choose not to gather kai moana from the Bay anymore - don't think it's safe.

Despite the recognised risks, a harvest of the bivalve shellfish from the Bay waters appears to continue.

Our uncle has got spots where he goes to get pipi and tuatua from along the beach here (Oneroa, Midway). He comes back with sackfuls.

Participants reiterated, however, that these were traditional kaimoana gathering grounds.

> *In the 70s as kids we used to gather kaimoana (specifically bivalves) down by big river, I remember how upset my whanau (especially my Nanny) was when the sign went up saying that shellfish could be contaminated. That was a traditional gathering site!*

When asked if, *Over time, and particularly over the last three years, have you noticed any differences in the types and quantities of fish or kai moana available and their quality* (Question 12), many respondents to the survey questionnaire pointed out that they do not gather kai moana from the Bay environment because of concerns with contaminants entering the system from farm run-off, sewage discharges, city stormwater, and Port activities. This was a similar response as other recreational water user groups who view avoidance as a necessary harm reduction strategy.

> *Don't get seafood from the bay go further up the coast*
>
> *Choose not to gather kaimoana from bay anymore - don't think it's safe.*
>
> *Do not gather seafood anymore due to pollution.*

Perhaps unsurprisingly, given the many variables appearing likely to effect the presence and quality of kai moana in the Bay, perceptions of differences in levels of abundance were mixed.

> *Not really. Feel commercial fishing has reduced once plentiful fish such as kahawai, and catching a snapper is but a distant memory.*

Although one respondent was clear that there had been an increase in numbers of finfish and their more even spread around the Bay, and four others agreed with this in relation to kaimoana in general, twenty seven questionnaire respondents felt that there had not been an improvement and, at least in some instances, there had been a decline in both quality and quantity.

> *Quality is not so good*
>
> *Fish reduced*

The discoloration of koura was commented on by a commercial fisher early in our research. This discoloration appears as a fungal, or mildew-like dark material closely attached to portions of the exoskeleton of the crayfish, particularly the tail extremities. The fisher stated that there is a large proportion of affected fish on the reefs in the Bay, but that they were also found adjacent to other river-mouth environments, possibly suggesting a sediment, or associated bacterial contaminant effect.

A strong and consistent theme amongst participants, however, was the desire for better and more open communication about the risks associated with harvest and consumption of kai moana from the rivers and Bay.

There were heaps of people at the beach gathering the shellfish. I wouldn't touch them. There should have been signs up telling that the waters were contaminated.

Turanganui a Kiwa Water Quality Enhancement Project

The Turanganui a Kiwa Water Quality Enhancement Project (TAK project) was established by the 2009 wastewater resource consent to provide a vehicle for the integrated research, monitoring, planning and specific projects that will aim to improve the mauri and the water quality of Turanganui A Kiwa (Resource Consent Decision, 2009, Clauses 18 and 19). Given the overall concerns relating to water quality in both the Bay and the rivers expressed by both the interview and discussion participants, and the survey questionnaire respondents, and their expressed understanding of the effects of catchment land management as well as wastewater management on water quality, it is not surprising that 69% of the 90 survey respondents indicated that the Turanganui a Kiwa Water Quality Enhancement Project was Extremely Important, 19% indicated Very Important, and 8% Important, while only 2% believed it was Quite Important and 2% believed it was Not Important (Question 20).

Question 21 of the survey questionnaire, *Would you like to be part of the Turanganui a Kiwa Water Quality Enhancement Project? Do you have any ideas on how such improvements might be made?* gave participants an opportunity to be linked into an ongoing role, and express their perspectives on the wider impacts on the waters of the Bay, and what might be done to improve the quality of these and the river systems further inland. By December 15th 34 of the 90 respondents wished to be involved.

It would be an honour and privilege to be a part of the Team.

Yes, I would love to be part of this project.

Respondents provided a cross section of suggestions as to how improvements might be made, including improved farming practices and better control of chemical and fertiliser inputs into waterways and improved management of our stormwater systems, reflecting what can be seen as an integrated catchment approach:

The rivers, from the head waters, need to be treated properly and landowners need to take more responsibility to manage run off which includes fecal coliforms from pastoral farming and sediment. The farming habits of 150 years need to take account of the reality that what used to happen cannot continue to happen, riparians need to be managed and nutrients retained on the farm. Industry, including farming needs to manage water discharge including natural run off.

In this context, some participants felt that there needed to be greater accountability from agricultural industries in the district:

> *Put some real responsibility and accountability on industries that take from our water table - the council needs to be much more restrictive about the usage ... develop a more robust system around management of water use. Put some task to those industries to make real contribution to the ongoing health of our waterways - fund cleanup projects. Have penalties for industries that fail in their obligations. GDC be more pro-active in these matters.*

Similarly, a range of practical opportunities were identified for improving our wastewater management:

> *Increase the use of sewage as a biofuel, and treated to level where it can be used as compost/fertiliser in suitable areas. eg in Tasman-Nelson they use it for pine forests on the Coast which has increased the forest productivity and at the same time disposed of sewage effectively and more appropriately, and improved water quality. Also a community action & education campaign, designed and led by the community and by Iwi (not GDC officials). Create opportunities for community energy and business energy to be innovative and achieve more wins.*

Community participation was also again a strong theme:

> *Regular water testing, daily interactive communication with water users & GDC, & Community participation & contribution with festivals, Gala's, etc to obtain the required financial backing & funding to facilitate the well-being of the beaches & environment.*

One respondent said that he would like the chance to put a proposal together under the TAK project umbrella.

Management of the whole wastewater process

As background to the discussions and responses to wastewater management in our region, we asked at Question 15*, Are you aware of the new system set up in December 2010 to treat Gisborne's municipal sewage?* At December 15th only 67% of 92 respondents to this question were aware, while a third, 33%, were not.

Three main themes in relation to wastewater management as a whole were evident from the water user representatives and groups interviewed. First, it was widely believed that the primary problem is the delivery system of wastewater to the new plant as opposed to the functioning of the plant itself. That is, overloading of the system through direct discharge of stormwater and infiltration via old, seeping infrastructure and damaged pipework, as well as the pressure from new subdivisions. An appreciation was evident, however, that upgrading of pipework may be difficult and costly, and require accurate estimates of population and urban growth.

Oldest of failing pipe system to be replaced with complete system overhaul before 2025.

A second theme was the understanding that cultural practices strongly determine waste management scenarios, signposting opportunities for synergies between traditional indigenous cultural practices and beliefs and contemporary science.

The third theme was simply that we need to look at ways of not discharging contaminants into the sea no matter what they might be. Looking to tried and tested techniques, what others are doing, and seeking good technical and cultural advice were suggested by questionnaire respondents alongside exploring new, practical ideas. This included having an updated and up-skilled strategic planning team, and more iwi and hapu involvement.

GDC needs to make it a priority to restore us to a more pristine environment by prioritising fixing up failing infrastructure, community-led education and action groups, innovative businesses to develop alternative uses for sewage, and being more honest and transparent with the public.

Several participants pointed to the need to encompass the wider waste processes, such as diffuse run-off from land, stormwater management, as well as the sewage overflows and current treatment processes. Waste minimisation was the focus in this context, and overall buy-in from industry and corporations that are either already here, or that are coming to town, was viewed as important.

Overall, at the end of December 2013, of 90 respondents to Question 25, *How important do you feel the management of our sewage wastewater is to the community?* 64% indicated that they felt the management of our sewage wastewater is Extremely Important, 27% felt it was Very Important, 7% Important, and 1% each for both Quite Important and Not Important.

Numerous respondents to Question 27, *Do you have any ideas on how the current management of wastewater could be improved*, made specific suggestions, including more through land treatment, the promotion of self-sufficient, decentralized waste treatment systems, and the encouragement of composting and alternative toilets and vermiculture. The utilization of our waste as a resource was a common theme, and suggestions were made for creating biofuel, compost, and water for reuse.

With considered additional treatment steps to enable reuse of effluent solids and liquids. Seeing the sewage as an asset to be managed is an approach to consider. The water has reuse values that are lost when it is run to sea. The solids can be converted to reusable bio solids.

Some people referred to achievements made since 2011 through the establishment of the new BTF system, and recommended continuing to deal with the issue in a balanced and affordable way. This perspective was qualified, however, by many respondents.

> *Compared to the later 1980's until 2010 the improvement is noticeable and good. However, you have asked me to rate our current management not looking back….any raw effluent disposal into any waterway around a population is appalling.*

This was reflected in the 88 responses to Question 26, *How would you rate the current management of the district's sewage wastewater?* 52% rating it as Poor, 28% as Satisfactory, 16% as Good, 2% Very Good, and 2% as Excellent.

The need for more emphasis on keeping Gisborne clean and healthy for future generations underpinned several of the respondents' comments.

> *It's all coming down to cost. Inside a 5 year plan, a strict & proactive approach to obtaining the required funds to maintain the longevity & health of our beaches, & a prospective, more efficient & strategic plan to better the current Sewage Treatment Plant, whilst maintaining a proficient consistency, will inevitably lead to a better environment & a happier, & healthier community for years to come.*

Responses from the wider community at the WTAG display at the Gisborne A&P Show and Tairawhiti Environment Day were somewhat different from the water user groups. One visitor to the display didn't realise a wastewater treatment plant had been built, whilst others thought that the wastewater project was all completed, rather than it being a work in progress, and that there might still be developmental decisions to be made. Most people spoken with were unaware of where the plant was located, and none had any idea about its daily capacity. Few knew that the plant was a Biological Trickling Filter (BTF) system, or what that meant, but all were interested to find out. People were interested too in the effectiveness of the plant, and keen to learn what ongoing options for treatment we have at this point, and the costs associated with these. No one was aware of the independent WTAG group, or of whom it was comprised, but people were supportive of the concept and appreciative to learn of its existence and role.

Communication and participation

Generally, there is a strong feeling amongst water users that the people are not well informed about the way the whole wastewater management system works, including both the treatment and disposal systems and the receiving environments. What was clear from all participants, however, was that they do want to know what's actually happening. One participant felt that there should be a community representative on the WTAG, while another pointed out that there are 2000 registered waka paddlers in Turanga and communication should be more face to face.

> *Why don't they come and talk to us? Why don't they come down to Anzac park during the winter and see the scum on the mud … that we got to walk through?*

Communication between GDC and water users, and participation by water user groups and individuals in the wider context of wastewater management was, overall, the most strongly advocated theme we heard within the water user focus groups. As regards the river sewage discharges, the participants were clear and measured in their discussion, stating that it would be preferable that the discharges do not happen, but if they do, that there needs to be adequate warning systems in place to protect the health of water users.

> *I give a 3 x per day radio surf report on 2 stations and during the recent overflow I was reporting that the surf was really good at the town beaches on the Monday and Tuesday. That Tuesday night was the first public notification of the overflow and that was 2 days after the discharge.*

There was also a strong indication that there needs to be a more honest approach from GDC, including better signage about potential health risks, education around wastewater processes, and possibly media notice of impending storm conditions likely to trigger a discharge. This, it is suggested, would reflect a more proactive approach from GDC, and one that includes water users themselves in helping formulate notification and information processes. Social media was seen as onea possible option for such a process.

Visitors to the WTAG stall at the A&P Show also made it evident that they believed that there needs to be better communication from the GDC, and for the public to be kept up to date, and anger was expressed regarding the lack of public notification with regards to the recently publicised overflow events. Comment was also made that, considering our beaches and coast are one of the main attractions to visitors, how can these discharges be happening? Once the sewerage capacity, system process, ageing infrastructure and direct inflow of stormwater were discussed, however, many were more understanding of the issues faced, although they continued to highlight the need for better communication and for keeping our community up to date with progress and options regarding our wastewater systems and management. This provided an opportunity for promoting the proposed wastewater plant open day.

Reflecting the importance of communication and participation, a local retail food outlet owner who wished to provide our survey questionnaire and flyers in his store, commented:

> *I am very keen to have the surveys, info stands etc. in my shop, and excited that community is being asked to participate! Many of my customers are Bay kai gatherers.*

Commenting on the discussions and questionnaire, another participant stated:

> *Buzzing that community being asked for input, involvement.*

Alongside a desire to participate in decision making, education was cited as key to improving people's ability to make informed choices about the current situation and any developments to come.

Just want to know what's going on! The community should be better informed on where whole wastewater situation is at.

GDC need to be more transparent. There should also be locals or iwi on board who have a say in management.

In particular, the desire for a much closer relationship between GDC and water users was strongly expressed, particularly triggered by the publicizing of the August sewage overflows.

Increase communication and consultation with public prior to any actions that GDC takes.

Public notification of dumping into waterways and sticking to their resource consent

I think that information about the discharge into the Bay should be more consistent and communicated better to the public. There should also be better signage about possible public hazards such as contaminated seafood.

More public awareness about the dumps. Need to work on healing the river and the moana. More information through avenues such as social media (facebook). Be creative and don't use money as an excuse.

A practical example of participants' willingness to become involved was evident when asked whether they would limit using chemicals and other materials that might be harmful to the environment when discharged through the wastewater treatment process, and 99% of the 94 respondents answered that they would. Similarly, when asked if they would encourage others to also limit their use of these, 95% stated that they would. By December 10th, 24 of the 110 respondents to the survey questionnaire wished to participate in ongoing forums relating to our rivers and the coastal environment, and provided their contact details for this purpose.

Upgrade of the sewerage system

There was an understanding amongst the water user representatives of the problems inherent in water based systems, and a clear desire to learn more of the options for sewerage system improvement. Some felt this should ideally translate in part at least into an aerobic system (e.g. composting of waste via composting toilets and/or solids retrieval). Overall, however, it was believed that with current system in place, it would be good for any further treatment options to have low energy and cost requirements, that could retrieve at least some of the nutrients, lipids, and organic matter in the waste, hopefully providing a compensating income stream, rather than simply disposing of the sewage material to waste at high cost.

Land based treatment and disposal was a popular choice, including oxidation ponds. So too was the reuse of both the solids and liquid components of the sewage. Options put forward included use as a biofuel, compost and irrigation for non-food

producing crops, and the use of the treated wastewater for industrial purposes. One participant spoke of 'dispersed treatment systems', simpler smaller treatment plants earlier in each arm of the system, followed by natural wetlands to store the treated wastewater prior to integration into the main sewer or alternative disposal or reuse.

> *With considered additional treatment steps to enable reuse of effluent solids and liquids. Seeing the sewage as an asset to be managed is an approach to consider. The water has reuse values that are lost when it is run to sea. The solids can be converted to reusable bio solids.*
>
> *Additional treatment steps are necessary along with determining alternatives to current disposal. Reuse is attractive and may reduce costs.*

Wider issues such as agricultural run-off and industrial discharges were also referred to, with emphasis on a greater need for accountability from these sectors in reducing the impacts on the rivers and the Bay. The sewage overflows to the rivers and the Bay were also seen as components of this wider picture and, in light of the information about discharges of untreated sewage during high rainfall events, representatives agreed that money should be directed to upgrading pipes and improving the wastewater delivery system.

> *There is a reality that our infrastructure needs upgrade. That will take time and resources. The objective to remove sewage from the outfall means every effort to tidy up, as best we can, the current use of scour valves is an important and priority task. The reality the rivers carry high levels of coliforms from animals does not mean the sewage overflows can be condoned. It does mean the land managers up stream need to lift the game and reduce/manage run off better.*
>
> *Need to work on healing the river and the moana.*

There appeared to be a consensus that wastewater treatment is a vital part of our society, and that we need to give it a high funding priority.

> *Find a land owner in the right place willing to donate land so a land based system can be put in place that meets all the legal and moral arguments of our local population including iwi Maori. A toilet based rating system if you flush you pay for the district. Sorry to those who don't want extra rates, we have to pay for this somehow.*

In response to Question 19, *The current consent to discharge treated wastewater to the Bay requires Gisborne District Council to find feasible ways to progressively remove treated human sewage from the ocean discharge, with the objective of complete removal by 2020. Do you have any ideas about how this might occur?* The dominant response was that we shouldn't be putting our wastewater into waterways in the first place. A corollary to this was strong support for land based treatment systems, and numerous questionnaire respondents described irrigation of forest crops, and other non-food producing uses for the liquid component of the

waste, with energy generation and composting as options for the biosolids. Oxidation and settling ponds were identified as possible further treatment methods.

> *Additional treatment steps are necessary along with determining alternatives to current disposal, including reuse options.*

One respondent suggested wetland treatment ponds, using fish to naturally 'clean' ponds, and then using those fish as fish food for aquaculture initiatives. A unique alternative was provided by another respondent.

> *Send it inland Wainui!*

Several visitors to the WTAG stall at the A&P show made further specific comments relevant to the biotransformation of wastewater. These included:

- A former environmental manager discussed the role and responsibilities that local key industries have to play in water quality;
- One local shareholder of family land commented that her whanau had always wondered why some of their land wasn't proposed for oxidisation ponds, and seemed supportive of the idea;
- One visitor discussed wastewater discharge meters and regulation as a tool to reduce wastewater volumes, but recognised that then we might have a plant built to over capacity;
- As was expressed by water user representatives and the focus groups, several visitors queried if the current sewerage infrastructure and treatment plant can cope with an influx of summer visitors, particularly if there should be a significant rainfall event.

On being shown information about, and discussing the Organica food chain reactor urban treatment process, one visitor suggested:

> *Wow! That's a wicked objective! Lets' create a beautiful environment of filtering plants and organisms that could also be a visitable habitat...*

The Bay as an integral part of our lives

The importance of the ocean, beaches and rivers to the water user groups and their representatives was clear and unanimous, namely, that water-based activities and the coastal environment are key to our region's distinctiveness and attraction, both for locals and visitors alike.

> *The rivers and the sea are my life*
>
> *The river is beautiful. We love it. It's our life. It's safe for learning, one of the best.*
>
> *The council should clean up their shit, it's been going on for years and years and I think we're just pretty much over it. Yea, they need to realize that that is our livelihood.*

Further, it was made evident that there are world class athletes here who use the rivers and Bay to train all year round. Given the high value placed on the coastal environment for recreation and tourism, including the brands Gisborne, East, and Te Tairawhiti, proper waste management was perceived as an investment in the region, and should be viewed as such, protecting and enhancing our critical assets.

At 22nd October 2013, when we assessed the responses to our survey questionnaire, 97% of the 67 respondents used the Bay or rivermouths for primary contact and secondary contact recreation and fishing or kai gathering. At 10th December, of the 91 respondents 98 % used these environments for these activities. 64% of respondents said they had been involved in these activities for greater than 15 years. When questioned about the frequency of this usage, 34% respondents said they did this greater than 10 times per month. This was slightly higher for primary contact recreational users, at 36%. In contrast, 36% of participants fishing and gathering kaimoana did so three or less times per month, although 11% did so more than ten times per month.

Health risk assessments: ESR and anecdotal records

Background

One component of the 2010 survey, *Te Moananui o Te Turanganui a Kiwa, Social Outcomes Evaluation of the Gisborne City Wastewater Treatment Project 2010 to 2013, Part 1: Baseline Information 2010* (Social Outcomes Evaluation) included a review of the health impact assessments of the existing discharge that had been prepared by Egis Consultants for GDC (Egis, 1999), and material then available from the ESR database of recreational water quality and recorded notifiable disease (ESR, 2005).

In general, Egis estimated that on an annual basis prior to 1999, 1-2% of the total population could be expected to contract a swimming-related gastrointestinal illness from swimming in the Bay. These risks would be highest during summer due to

higher overall water usage. The authors also noted the increased risk of ear infections from swimming as faecal coliform levels rise (Egis, 1999).

Information available from the Environmental Sciences Research (ESR) 'Environmental Indicators' database relating to recreational water quality and the incidence of reported contact recreational waterborne disease indicated that for the 2003-4 season, 3.4% of marine recreational water samples in the Gisborne region exceeded the standard, and in 2004 there were 11.1 reported incidences of related disease per 100,000 population. Generally, in the Gisborne region, the incidence of such diseases ranged from 6.7 to 11.1 per 100,000 for the 2003, 2004 and 2006 years, similar to those for Whangarei, whose numbers ranged from 9.4 to 12.1 per 100,000. Outlying these figures, however, in 2005 the incidence of recorded recreational waterborne diseases in Gisborne was the highest in the North Island at 33.6 per 100,000 (cf 2005, Whangarei at 11) (ESR, 2005).

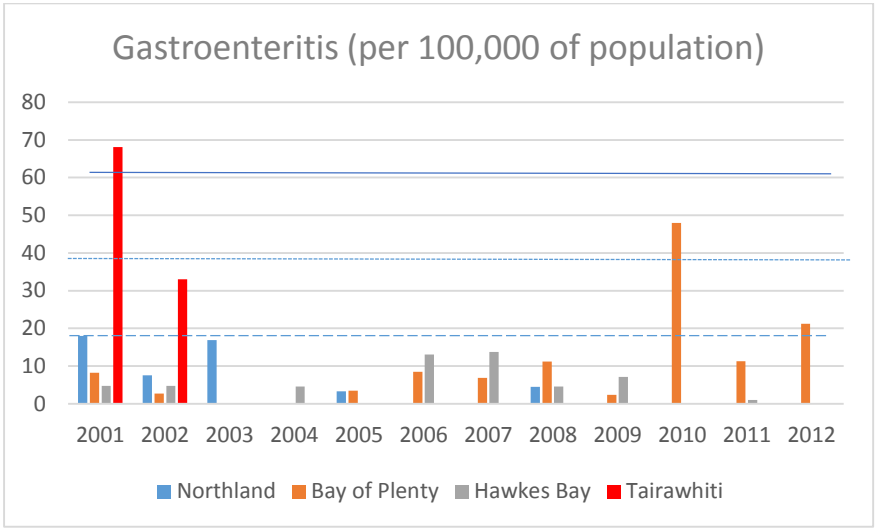
Over the years, however, contact recreational water users have given anecdotal evidence of poor water quality, and the associated adverse health effects of swimming, surfing and paddling in the Bay (Awatere *et al*, 2000). Much of this evidence indicated the wastewater outfall as the likely primary source. For these reasons, and in the absence of relevant epidemiological studies, the current report reviews the available ESR notifiable disease data in the context of improvements in the quality of the outfall discharge post-commissioning of the wastewater treatment plant in January 2011, in order to assess the possibility of any concomitant trend in notifiable disease reporting.

Due to changes in the methods of information gathering and reporting that ESR now use, and in the light of recommendations from Alan Yager (Yagar, 2011), we report on the years from 2001 to 2012 for the following disease vector groups, commonly associated with faecal contamination:

1. Gastroenteritis
2. Camplobacteriosis
3. Cryptosporidosis
4. Giardiasis
5. Salmonellosis
6. VTEC/STEC
7. Yersiniosis

Alongside Te Tairawhiti region, annual data from Northland, Bay of Plenty and the Hawkes Bay were recorded for the seven vectors, and the maximum, minimum and median levels from Auckland for Gastroenteritis for the 12 year period were also included. It should be noted that incidences of less than 5 individual cases of specific diseases are recorded by ESR, but not included in their percentages per 100,000 of population. Results of the ESR reporting are as outlined in Figures 1 to 7 below.

Figure 1 Gastroenteritis recorded cases per 1000,000 popn. (ESR, 2013)

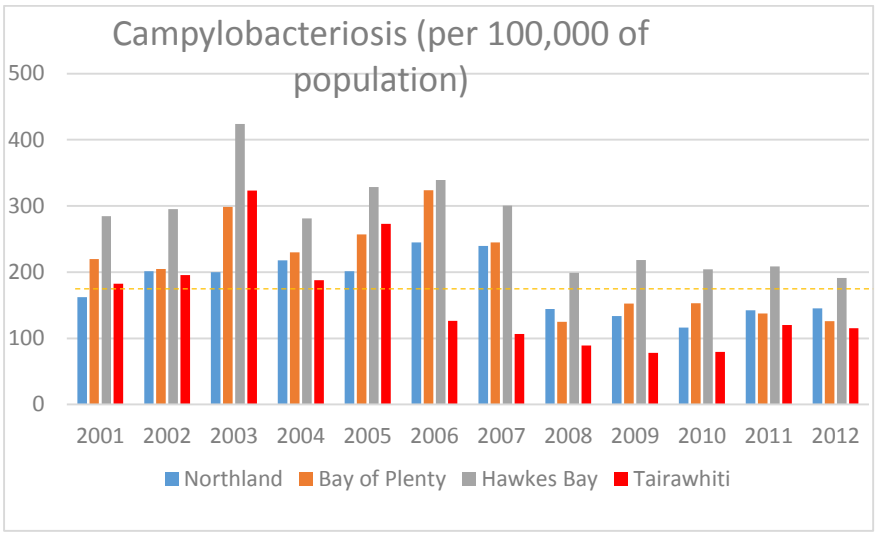


AUCKLAND
Max

Median

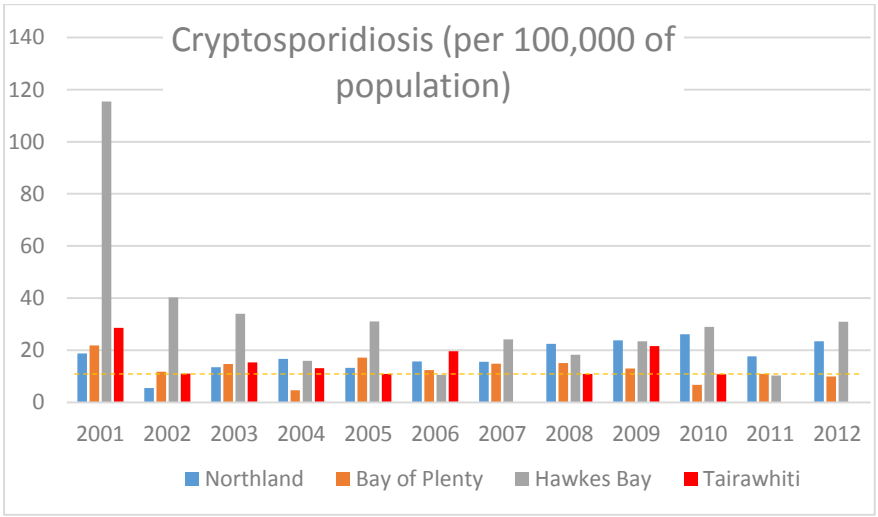
Min

Figure 2 Camplyobacteriosis recorded cases per 1000,000 popn. (ESR, 2013)



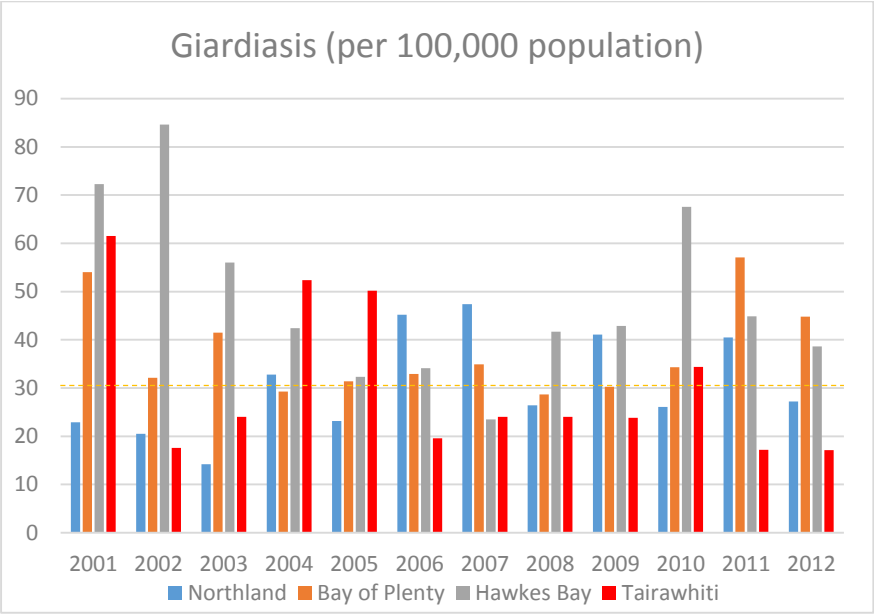
Tairawhiti median
156.45

Figure 3 Cryptosporidosis recorded cases per 1000,000 popn. (ESR, 2013)



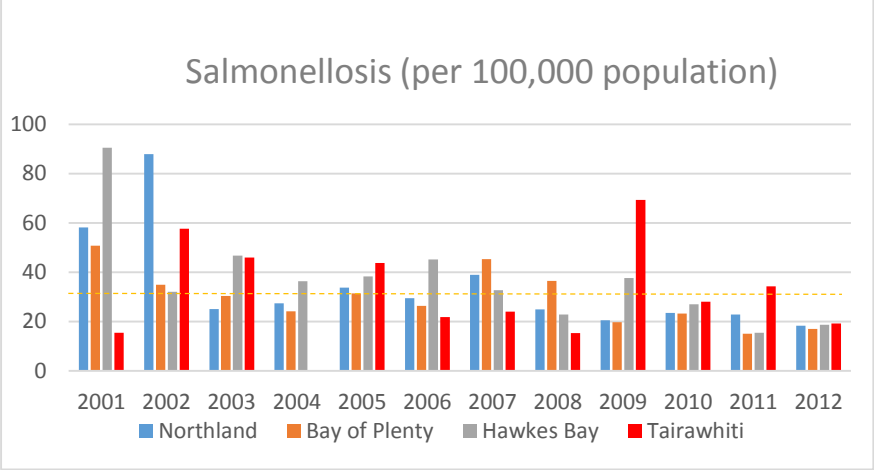
Tairawhiti median
11.82

Figure 4 Giardiasis recorded cases per 1000,000 popn. (ESR, 2013)



Tairawhiti median 30.48

Figure 5 Salmonellosis recorded cases per 1000,000 popn. (ESR, 2013)



Tairawhiti median 31.22

Figure 6 VTEC/STEC recorded cases per 1000,000 popn. (ESR, 2013)

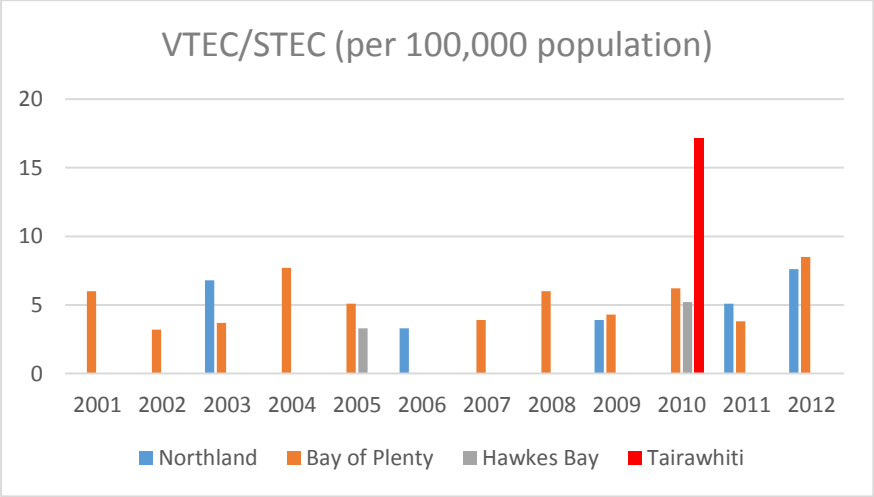
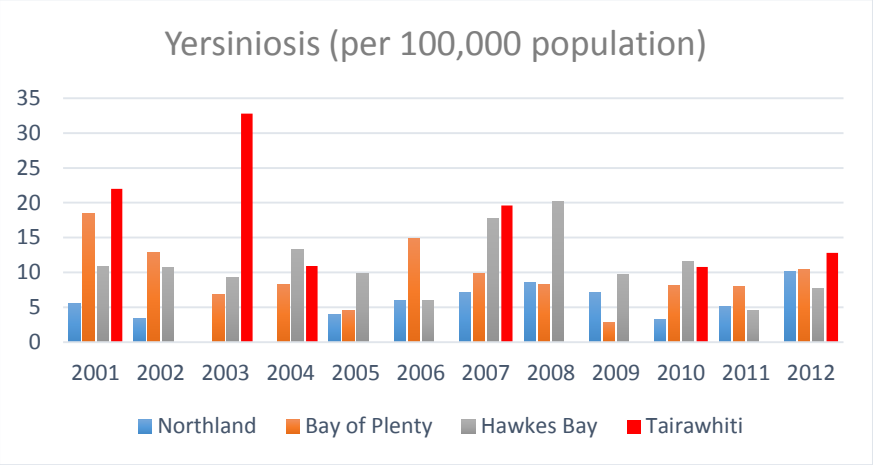


Figure 7 Yersiniosis recorded cases per 1000,000 popn. (ESR, 2013)



Discussion

Overall, across the key potential disease vectors and gastroenteritis there appears to be no distinctive trend effect, post-commissioning of the wastewater treatment plant early in 2011. This report suggests, however, that several important factors need to be taken into account when considering the ESR data in terms of the potential health effects of the Gisborne Turanganui wastewater discharge to the Bay. These may be summarised as follows.

- Gastrointestinal and related diseases are typically underreported, with evidence such underreporting may be 75% or more (ESR, 2005; pers com Drs Bruce Duncan and Brian Gibson, 2013; ESR, 2012) and without specific epidemiological studies relating to at-risk populations of recreational and food gathering water users, it is considered difficult if not impossible to accurately assess past and current illnesses associated with water quality, suggesting that information from public health databases relating to disease pathways will be naturally inconclusive;
- Further, there may be many pathways for such diseases to be contracted, including compromised immune systems, and poor housing and living conditions and the like;
- The new wastewater treatment system has only been operating for two and a half years, and during this time there have been nine emergency discharges of untreated sewage to the urban river deltas, and several similar overflow discharges directly via the marine outfall, both of which might be expected to confound health risks when compared with the discharge of BTF treated effluent solely via the outfall.

Despite such difficulties associated with the ESR data sets, this report suggests that certain elements may be of interest, albeit of inconclusive statistical relevance. These are:

- There appear to have been no greater than four incidences of gastroenteritis reported in Te Tairawhiti since 2002, while for the Bay of Plenty a marked increase is discernible 2010 to 2012, when the median of reported cases was 27 per 100,000 population. The Auckland median over the 2001 to 2012 period was 38 per 100,000;
- There was a discernible decline in three vectors associated with gastrointestinal type disorders. These were:
    - Camplyobacteriosis, which showed a significant decline in reported cases from 2006 to 2012, during which time the highest reported year was 120 cases per 100,000, and the median was 102, compared with an overall median from 2006 to 2012 of 156;
    - Cryptosporidosis, which showed an overall weak downward trend in cases over the 12 year period, including 2010 exhibiting 11 cases (below the overall median of 12) and no cases reported during 2011 and 2012;
    - Giardiasis, which showed an apparent overall trend downward trend over the 12 year period, with the lowest number of cases (17 per 100,000) of the period reported for both 2011 and 2012.
- There appeared a possible overall trend downwards in Salmonellisis, with the median for 2011 and 2012 at 27 compared with an overall median for the 12 year period at 32. Nevertheless, in 2009 the highest incidence of the disease over the period was recorded at 68 per 100,000;
- The vectors Yersiniosis and VTEC/STEC, however, showed increases and levels considerably higher than the other regions cited. In 2010, the only reported outbreak of VTEC/STEC in the 12 years cited, the incidence of 17 per 100,000 was twice that of any year or region, the next highest being the Bay of Plenty having 8 per 100,000 in 2012. Similarly, Te Tairawhiti had the highest incidences of Yersiniosis of the four regions in four of the 12 years surveyed, and the highest incidence of all at 33 per 100,000 in 2003 (the next highest being Hawkes Bay at 20 per 100,000 in 2008.

Despite low levels of reported notifiable disease, Gisborne Te Tairawhiti does appear to experience regular periodic outbreaks of gastrointestinal type illnesses. The most recent of these was at Gisborne Hospital on the 28th November 2013, when visitor access to the hospital was restricted after an outbreak of gastroenteritis among patients and staff. Just prior to this event at the hospital, two of the city's aged care facilities had imposed visitor restrictions over the preceding two weeks, due to a similar gastroenteritis outbreak resulting in vomiting and diarrhoea that affected residents and staff members.

On August 28th, approximately three months prior to these outbreaks, and two weeks after the discharge of raw sewage to the city rivers, three Gisborne schools reported greater than normal outbreaks of gastroenteritis-like illness, with a fourth school monitoring student sick days closely. Over this period Gisborne schools were urging parents to keep children home at least 24 hours after tummy bug symptoms have cleared. In reports to the Gisborne Herald, spokespersons from Gisborne Intermediate stated that the school has experienced students afflicted with 'gastro bug-like' illnesses for most of the year. This had flared up in August, along with winter colds, strep throat and a handful of chicken pox cases. On Monday 26th alone, 60 children were at home sick and there was an average of 20 a day for the rest of the week, a staff member said.

Gisborne Boys' High also reported ongoing instances of 'tummy bug' illnesses, with a large number of students away over the period since the end of term two, and Gisborne Girls' High also reported 'a greater number than normal' suffering from diarrhoea and vomiting bugs. While Te Hapara School principal Kaye Griffin confirmed there were a lot of children off school sick with gastro bugs, she felt that at this stage it was part of the normal winter cycle of illnesses. Similarly, Three Rivers Medical manager Andrew Tucker said while they had some busy months, this had been a relatively mild winter and they were not aware of any particular spikes in gastro bugs.

Although the November 2013 outbreak at Gisborne Hospital proved to be attributable to Sapovirus, a common cause of gastroenteritis in adults, Norovirus and Rotovirus have been described as the two most common microorganisms causing vomiting and diarrhoea outbreaks amongst both adults and children in the Gisborne region (Dr Cramp, Gisborne Herald, November 2013).

In November 2010, at the instigation of the WTAG, bivalve shellfish were gathered from eight sites around the river deltas and coastal environments of Te Turanganui a Kiwa. These shellfish were transported to the ESR laboratories where they underwent a DNA assay to assess the presence and potential levels of human pathogens in these waters. The rationale for this piece of research was to provide an assessment of specifically human faecal contamination in the waters of the river delta and Bay environments prior to (and after) the establishment and functioning of the Gisborne wastewater treatment plant and ongoing system.

Five species of Norovirus were utilised for the assay, including two specifically of human origin. Of the seven sites in the river delta and coastal Bay environment, all had bivalve shellfish that contained human norovirus, with levels ranging from Low to Very High. While these results were prior to the treatment plant establishment, recent research has indicated that Norovirus (and some other pathogens) is able to pass through the BTF system.

Considering the low levels of reported cases of gastrointestinal illness in the region, alongside what appears to be frequent occurrence, at least at certain times, of such illness in the community, the presence of human Norovirus in all bivalve shellfish

from the Bay and Turanganui River environments (excluding Te Wherowhero Lagoon) prior to the wastewater treatment plant commissioning, the ability of the virus to survive through the BTF treatment system, and the periodic discharge of untreated sewage to the rivers and Bay during high rainfall events, it would appear that the reservoir of human pathogens may be more ubiquitous than previously believed, and may be being regularly replenished.

BTF plant effluent and receiving environment water quality

BTF plant effluent data

Since January 2011, a range of physico-chemical and microbiological characteristics of the municipal wastewater have been monitored on a weekly basis before and after treatment through the BTF plant. The results of this monitoring program have been summarised and evaluated in a draft report to GDC in April 2013 by the ESR, and form the basis of the BTF plant effluent data information provided here.

Major contaminants in wastewater are biodegradable organic compounds, volatile organic compounds (VOCs), recalcitrant xenobiotics, toxic metals, suspended solids, nutrients (nitrogen and phosphorous) and microbial pathogens and parasites. A sewage treatment process needs to reduce or remove the contaminants sufficiently that the discharge from the wastewater plant is environmentally acceptable for disposal. The key issue addressed in the ESR project was the extent of microorganism reduction achieved by the BTF plant. The level required of the Gisborne discharge is <1,000 enteroccocci per 100 mL (after the instillation of UV treatment) and is a target of many wastewater treatment plants in NZ. The influent to the plant contains an average of 862,000 enterococci per 100 mL. The BTF has been able to reduce this by an average of 1.2 log, resulting in average level of enterococci after the BTF of 67,000 CFU/100 mL. The consent condition of 1,000 CFU/100 mL was not meet on any occasion, and even using the maximum observed reduction in the BTF (1.7 log), this limit would still be exceeded on every occasion.

Other microorganisms were also tested for by ESR, and they concluded that, although enterococci may be a suitable indicator of bacterial removal through the BTF, some more hardy organisms such as protozoa (e.g. the pathogens Cryptosporidium and Giardia), bacteriophage (a type of virus), and Clostridium (surrogate indicator for protozoa) are not removed as efficiently. Similarly, molecular assays of specific human derived microorganisms found that:

> *The human indicative markers were detected in the effluent following passage through the BTF. Of the human specific microorganisms, an average of 10% of the bacterial human indicator (Bacteroides) and 60% of the human viral indicator (Polyomavirus) remained in the effluent.*

The third indicator of human sewage in effluent utilised were fluorescent whitening agents (FWAs). FWAs are added to washing powder to brighten clothing and, as

greywater, become an integral component of most human sewage. FWAs are broken down by sunlight exposure, or absorbtion to solids, and sedimentation tanks typically remove significant amounts of these materials. The high levels of FWAs in sewage make them a potentially good indicator of the fate of other recalcitrant chemicals that may be present at much lower levels that are difficult or very expensive to detect. The Gisborne BTF treatment resulted in no degradation or removal of FWAs in the BTF.

Concentrations of some contaminants comprising the Gisborne wastewater effluent discharge over time are outlined in Figures 8 to 11 below.

Figure 8 Concentration of total suspended solids at the outlet of the BTF

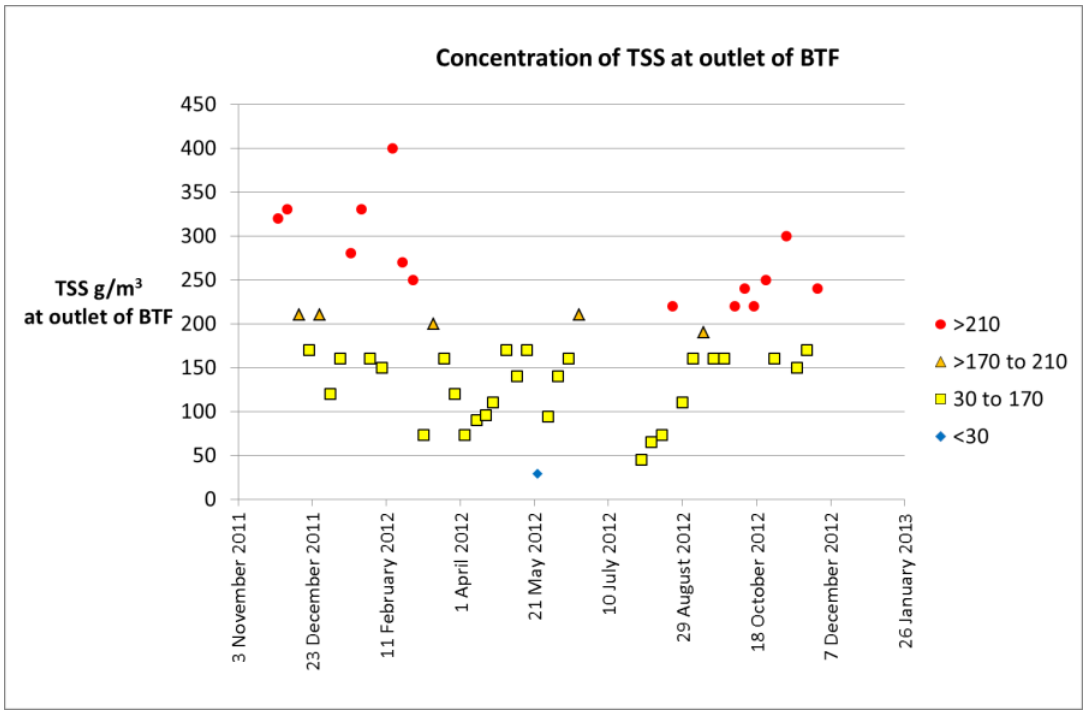


Figure 9 Total oil and grease at the outlet of the BTF

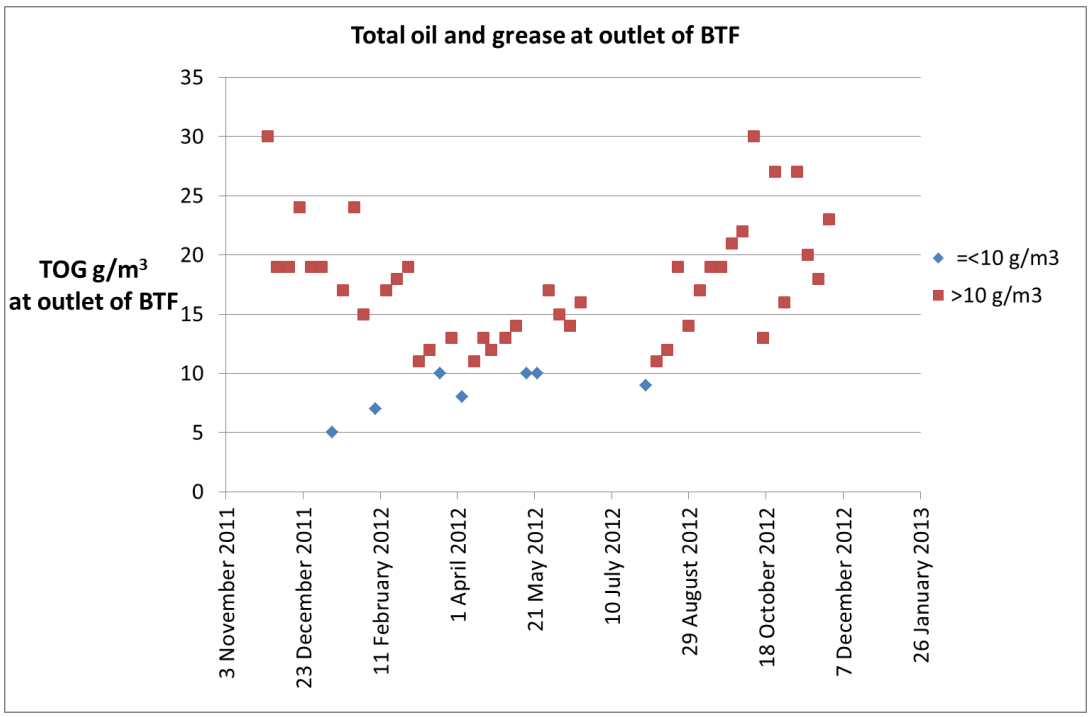


Figure 10 Biological oxygen demand per m3 of media per day

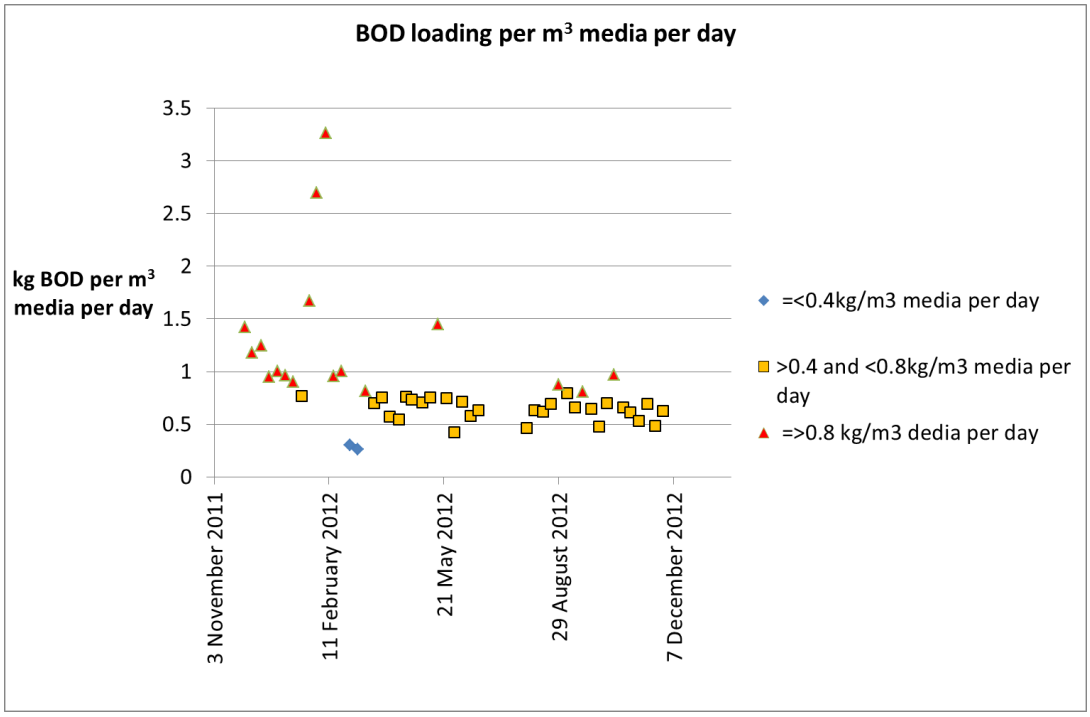
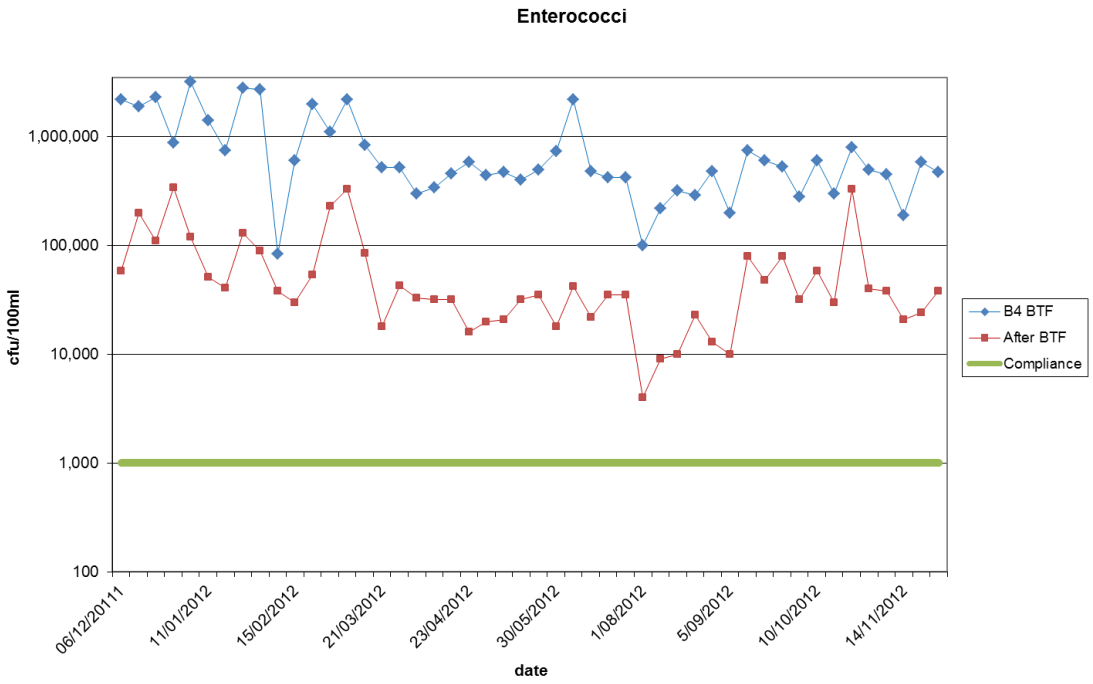


Figure 11 Enterococci colony forming units per 100ml effluent



The removal rates of indicator microorganisms (*Enterococci sp.*) observed in the Gisborne BTF are at the higher end of removal rates reported previously from similar treatment systems. The large size of the Gisborne BTF, the use of high surface area plastic media, and moderate loading rates probably all contribute to this better than average performance by the Gisborne BTF compared to other similar system examples. Nevertheless, the ESR authors conclude, additional improvement in the BTF removal rates are probably unrealistic and to further reduce the concentration of indicator microorganisms, additional treatment is required before or after the BTF.

> *Our overall conclusions are that the BTF is functioning at least as well as could be expected for this type of wastewater treatment. The BTF achieves about the same treatment effectiveness as oxidation pond treatment, but it does so with a much smaller footprint and it does so with a much shorter retention time. Therefore, BTF may be a technological consideration for communities where increasing the capacity of ponds or managing ponds susceptible to flooding is a problem.*
>
> *However, as the primary wastewater treatment element, the BTF is unlikely to treat sewage to a level that will meet New Zealand expectations for microbial removal or community expectations for biotransformation. Additional treatment steps, either before or after the BTF, are required to increase the removal rates and the levels of biotransformation.* (ESR, 2013, p44).

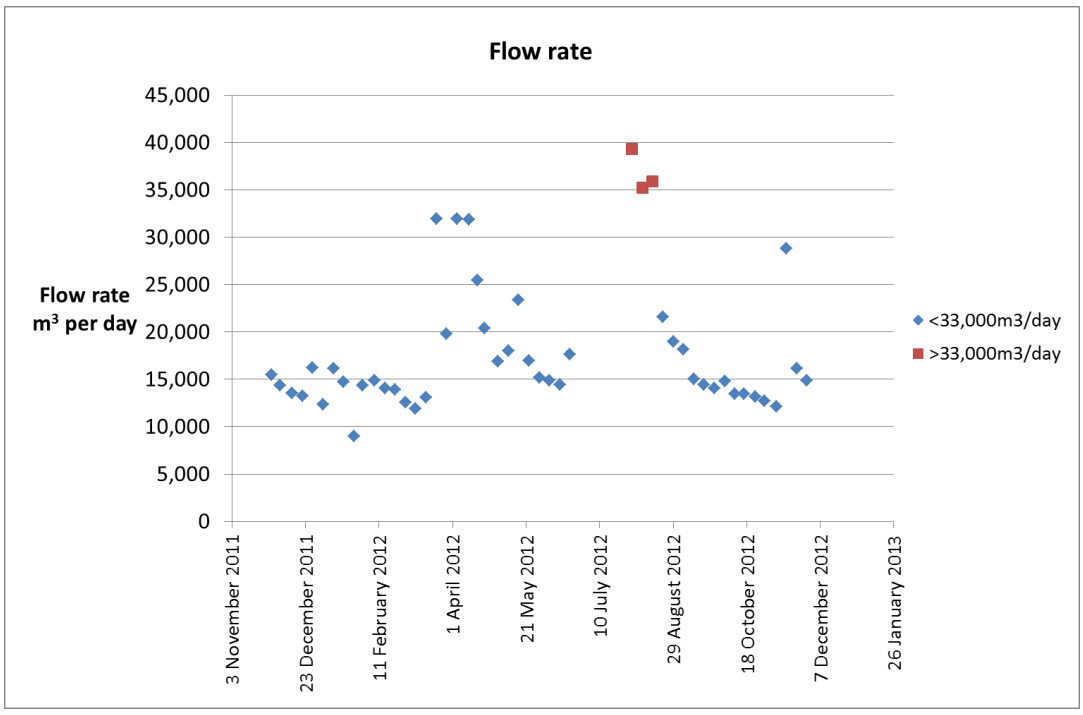
Te Turanganui a Kiwa receiving environment microbiological water quality assessment

Bevan Turnpenny (2014) has also provided an initial evaluation of the recreational water quality and outfall consent enterococci monitoring, both prior to, and post BTF plant commissioning. Although acknowledging that post plant commissioning contains less than three years of data, nevertheless the evaluation (to be published) indicates a distinct improvement in the levels of indicator bacteria in the areas around the outfall and at Waikanae and Midway Beaches, although there also appears evidence of a decline in water quality in the Turanganui River.

Periodic discharges of untreated sewage to the Bay and Gisborne city rivers

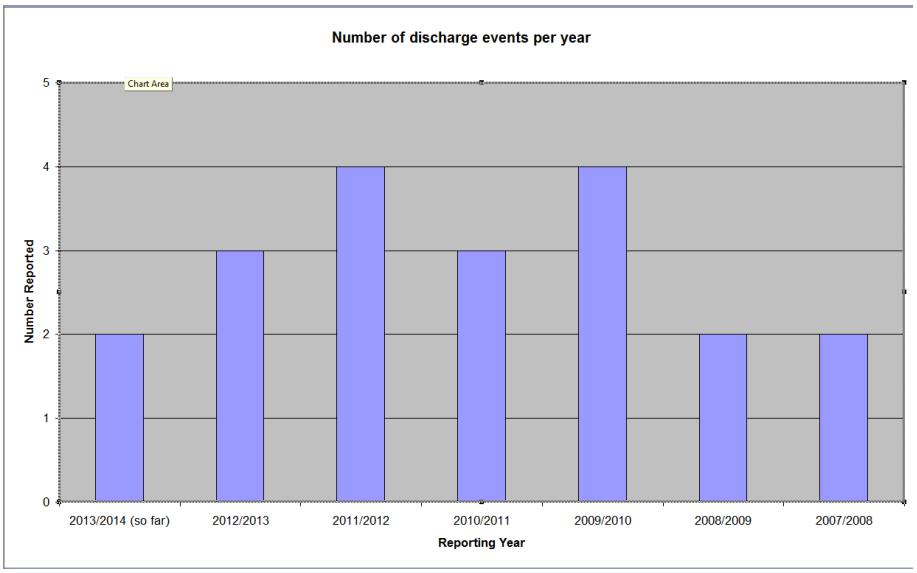
Discharges of untreated sewage directly to the city rivers from the system holding tanks and to the Bay prior to treatment in the BTF plant, appear to be associated primarily with intense or protracted rainfall events that overburden the capacity of the sewerage system and treatment plant. This has been the case for numerous years. Indications of the frequency of such events since the commissioning of the BTF plant in January 2011 may be evident from the flow rates through the plant (Figure 12 below).

Figure 12 Flow rate to the wastewater treatment plant November 2011 to January 2013 (ESR, 2013)



Discharges to the city's rivers prior to the BTF treatment plant can be expected to reduce the volume of sewage entering the plant system, and thus incidences when untreated sewage has to be released from the plant itself. The number of such discharges to the rivers reported since 2007/8 are identified at Figure 13 below, however incidences of direct discharges over the BTF plant weir and via the ocean outfall are yet to be reported on.

Figure 13 Number of discharges prior to the BTF plant system per annum



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Personal communications

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Dr Geoff Cramp. Medical officer of health. Gisborne. Re implication of norovirus in gastrointestinal type disease outbreaks.

Appendix 1

Table 2	**Project activities and time line**		
Activity		*Present to WTAG*	*Activity due date*
1	Identify project team and finalise proposed research outcomes.	August	September
2	Identify key water user and related groups.	August	September
3	Identify group representatives to provide initial responses and assist with focus group formation.	September	September
4	Collate information relating to community health (ESR) that might be related to recreational water use; collate background information relating to local household socio-economic characteristics.	November	November
5	Develop information hand-out relating to the establishment and functioning of the BTF plant and wastewater management in Turanganui a Kiwa for use as background information for interviews and discussion.	Mid-September	Mid-September
6	Conduct semi-structured interviews with water user and related activity representatives; provide the questionnaire for comment and completion (eight interviews).	September-October	November
7	Receive completed questionnaire; review information hand-out and questionnaire in the light of representative responses; collate information.	Early November December	Early November December
8	Place the questionnaire online via the *He Awa Ora, He Tai Ora, Healthy Rivers, Living Sea* facebook page.	Late – September	Late - September
9	Develop an information stand for community events (A&P Show; Tairawhiti Environment Day) relating to the establishment and functioning of the BTF plant wastewater management in Turanganui a Kiwa.	October 2nd	Mid-October Early November
10	Conduct focus group information sharing and discussions; provide the questionnaire for comment and completion (eight group sessions). Option to complete questionnaire on-line.	Late – September	Late – September to early - November
11	Receive completed questionnaire forms; collate information.	October 2nd	Late - Otober
12	Establish information stands at community events (A&P Show; Tairawhiti Environment Day); man stands; answer queries from the public and provide questionnaire for completion.	Mid - October	Mid – October Early november
13	Collate: • Discussion group information		Mid November

	• Individual perceptions at community events • Completed questionnaires		
14	Provide report to WTAG	November 6th	Late November