EFFECTIVE OVERFLOW MANAGEMENT

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ABSTRACT

Combined Sewer Overflows (CSOs) are prevalent in the older combined New Zealand wastewater catchments but more polluting Sanitary Sewer Overflows (SSOs) are also relatively common in more recent separate networks. The discharge from these structures can adversely impact the receiving natural environment. The Ministry for the Environment has developed guidelines for the microbiological performance of key areas in the receiving environment (bathing beaches, shellfish waters, and inland recreational waters). This paper looks at the impact of CSOs and SSOs on the receiving environment, and discusses the most effective methods for assessing their impact, and significance, prioritising the worst offenders and then designing effective management and improvement programmes.

KEYWORDS

CSO, Water Quality, Discharge, Cost Effective

1 INTRODUCTION

Combined Sewer Overflows (CSOs) or Sanitary Sewer overflows (SSOs) are a common problem around the world. Watercare is undertaking significant infrastructure investment to reduce wastewater overflows with a forecast wastewater network capital expenditure of $1.2 billion dollars over the next 20 years. Approximately $400M is dedicated directly to reducing wastewater overflows, with a further $500M indirectly related. As an efficient water and wastewater utility, Watercare must ensure investment to reduce wastewater overflows is targeted and justified.

This paper will discuss the initial findings and potential actions around the Water Quality in the Freshwater streams that contribute to the Tamaki River. It should be noted that this study is ongoing. The proposed Auckland Air Land and Water Plan now refers to the Best Practicable Option (BPO) to manage adverse effects on the environment from wastewater overflows. As part of Watercare's investigations into solutions, it is evaluating an alternative management technique to the two spills per annum that has been commonly adopted as the standard in the Auckland region. Overflows and leaks from wastewater networks have a variety of adverse environmental effects, but in particular create risks to the health of people undertaking water based recreational activities (Auckland Air Land and Water Plan 2009). In the Auckland context should therefore be on bathing beach water quality and the risk to public health, and secondly to the water quality of streams and creeks.

In the UK, a similar approach has been adopted that is known as the UPM methodology and can be defined as '*the management of wastewater discharges from sewer and sewerage treatment systems under wet weather conditions such that the requirements of the receiving water are met in a cost effective way*'. It is anticipated that the next phase of work will closely link into this standard for the Freshwater analysis.

2 BACKGROUND

Watercare is the bulk water and wastewater supplier in the Auckland region, managing 99 constructed overflows to relieve the trunk wastewater system during wet weather events. The frequency and volume of overflows from the wastewater system vary throughout the network. The receiving environment also differs for each overflow. As a result a pragmatic approach to the effective management of intermittent discharges is required to provide a wastewater service that is economically viable, environmentally sound, socially responsible and responsive to customer needs to all people across the Auckland region.

Watercare is investigating the existing effects of the wastewater overflows and the nature of the problem to be addressed. The first step is to gain the best possible understanding of the current performance of the urban wastewater system using existing information. Following this, Watercare will assess the impact existing overflows are having on the environment and the risk to public health. The Tamaki North wastewater system was selected as the trial catchment for exploring an alternative management technique. The following sections of this paper focus on the existing performance of the wastewater system, providing analysis of existing water quality data in order to quantify the extent of the wastewater problem.

The deliverables of this study was "To assess the existing water quality of the Tamaki Estuary, in terms of meeting statutory water quality drivers and associated costs and benefits".

3 TAMAKI NORTH WASTEWATER SYSTEM

Watercare (trunk wastewater network provider) recently completed a joint planning study with Metrowater (local wastewater network provider) into wastewater services for the Tamaki North wastewater catchment. The Tamaki North wastewater catchment has a total contributing area of 1,386 hectares, with 125km of wastewater reticulation, including 8 pump stations and 13 constructed overflows. The catchment is bounded by the Tamaki River in the East, the Waitemata Harbour to the North and Maskell St and St Heliers Bay Road define the western portion (Maunsell 2008).

The joint study identified that the existing system performance of the Tamaki North wastewater system does not comply with current target of two spills per annum and that significant growth is planned for the wastewater catchment. The 2006 census population is expected to increase from 29,147 to 47,995 by 2051 (a 65% increase) through urban intensification. The Tamaki North catchment is a complex and intricate network that has many drivers and issues resulting in a varied reaction to rainfall, and therefore a large range of spills from SSOs.

The Tamaki North wastewater catchment contains a large number of state houses. It is commonly found that areas with significant state housing have high levels of inflow and infiltration that can exaggerate overflows. Several SSOs in the catchment act similar to CSOs in terms of frequency and volumes. The proposed re-development by Housing New Zealand in the Tamaki North wastewater catchment is expected to reduce the current levels of inflow and infiltration and enhance the effectiveness of the stormwater system.

The Tamaki North Joint Planning Study identified solutions to address wastewater overflows and service the expected growth with a total cost of $32M. One of the preferred solutions to address significant wastewater overflows was the provision for a 12,800m^3 storage tank located on the Glen Eden branch sewer adjacent to the constructed overflow at manhole 8 as shown in Figure 1. The storage tank would provide storage for three major overflow structures. It is estimated that an underground tank would cost approximately $22M (based on a cost estimate of the proposed 13,000m^3 Concourse Storage tank, Waitakere).

The proposed storage tank would be a significant civil engineering structure and would have the capacity approximately equivalent to 5 Olympic swimming pools. An indicative structure would be approximately equivalent to a structure 50 x 50 x 5m. A reduction in the size of the proposed storage tank would provide significant cost savings.

3.1 OTHER PROPOSED WASTEWATER PROJECTS

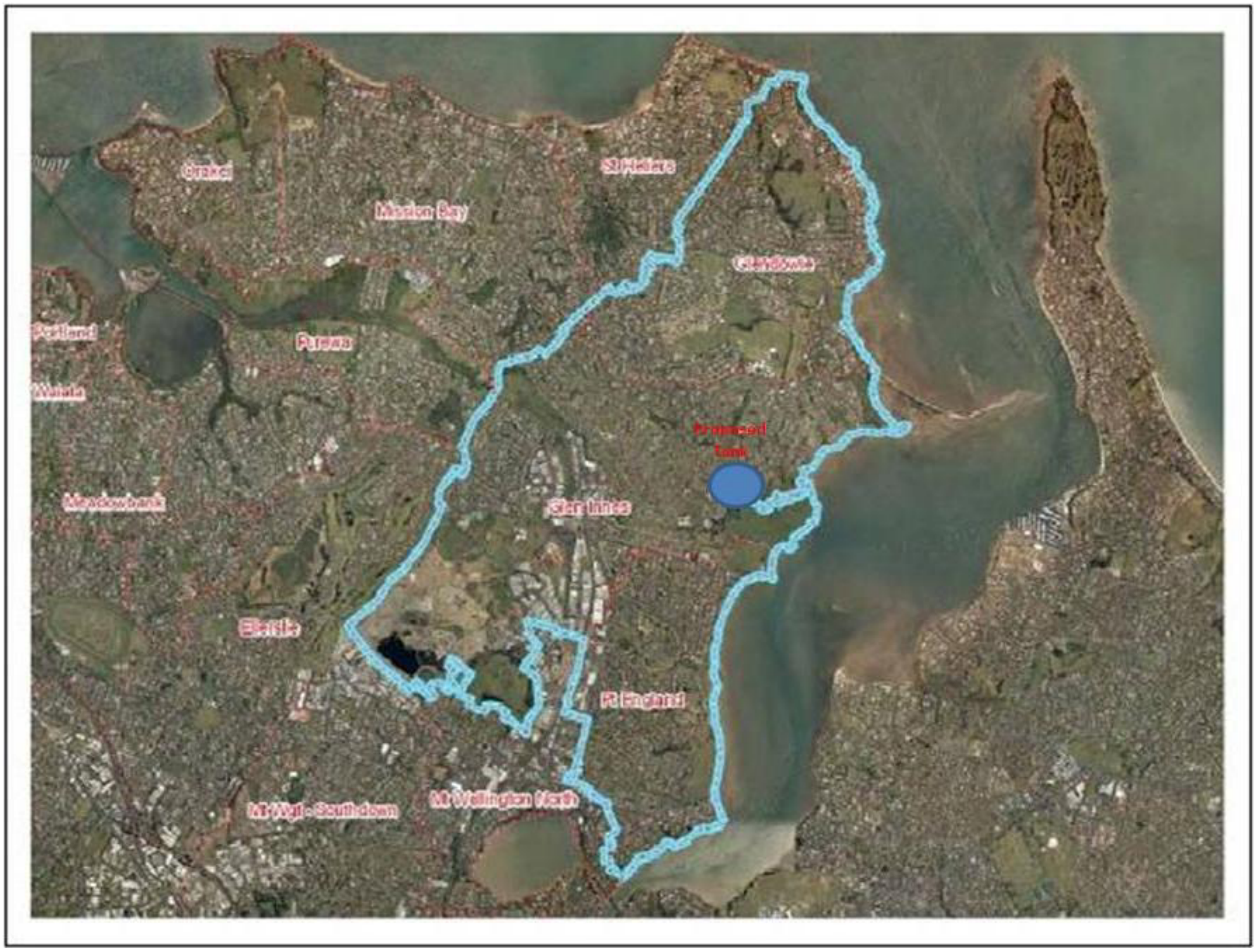
In reviewing the water quality results it is important to consider other planned wastewater projects designed to reduce overflows and subsequently improve the water quality of the Tamaki River. The following projects are currently planned in Watercare's Asset Management Plan:

1. Otahuhu North Pump Station and Branch Sewer Upgrade (Design has begun, Expected Completion 2012)
2. Otahuhu East Diversion (Design has begun, Expected Completion 2011);
3. Buckland Beach Branch Sewer Upgrade (Expected Completion 2013);

4. Botany Diversion Upgrade (Expected Completion 2020);
5. Otara Storage Tanks and Branch Sewer Upgrades (First upgrade completed by 2015);
6. Sylvia Park Pump Station Storage tank (Expected Completion 2021);
7. Botany Diversion Upgrade (Expected Completion 2023);

Indirectly the South Western Interceptor Extension Project (Expected Completion 2012) will reduce flows in the Southern Interceptor, as well as reducing overflows and backwater effects on incoming sewers such as the Otara and Papatoetoe North Branch Sewers.

Figure 1 – Wastewater Catchment

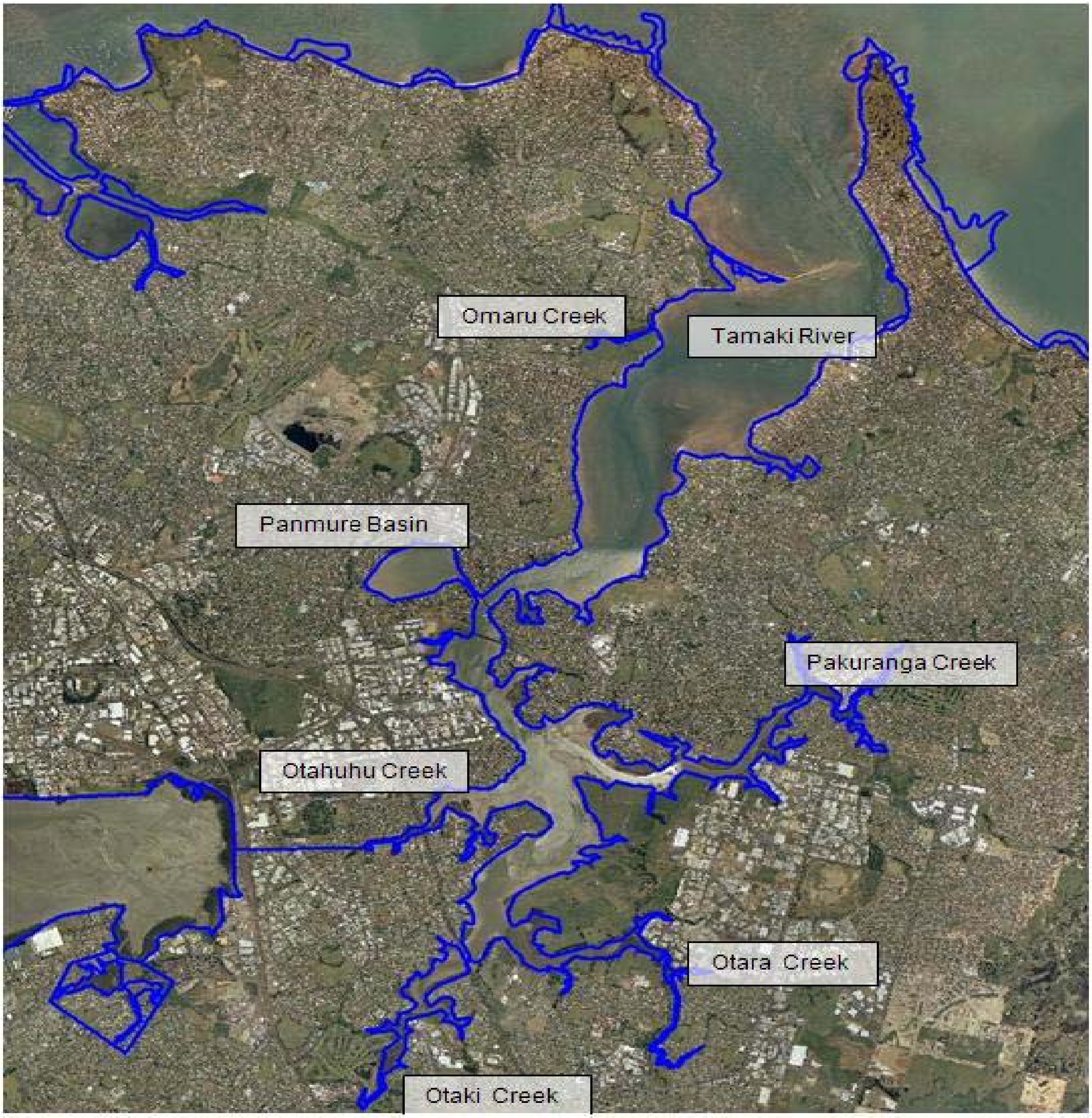


4 RECEIVING ENVIRONMENT

4.1 THE TAMAKI RIVER

The Tamaki River drains the eastern suburbs of Auckland to the Hauraki Gulf. The Tamaki River is largely tidal and relatively shallow, with large mud flats becoming exposed at low tide. The mud flats support extensive shellfish beds and are a feeding ground for many species of native wading birds. The river and its surroundings are designated under a number of Coastal Protection Areas as defined in the Auckland Region Plan: Coastal (ARC) .The River is served by a number of freshwater, urban creeks as shown below in Figure 2. Some of these, such as the Pakuranga Creek, also have areas of Mangrove.

Figure 2 – The Tamaki River and Tributaries

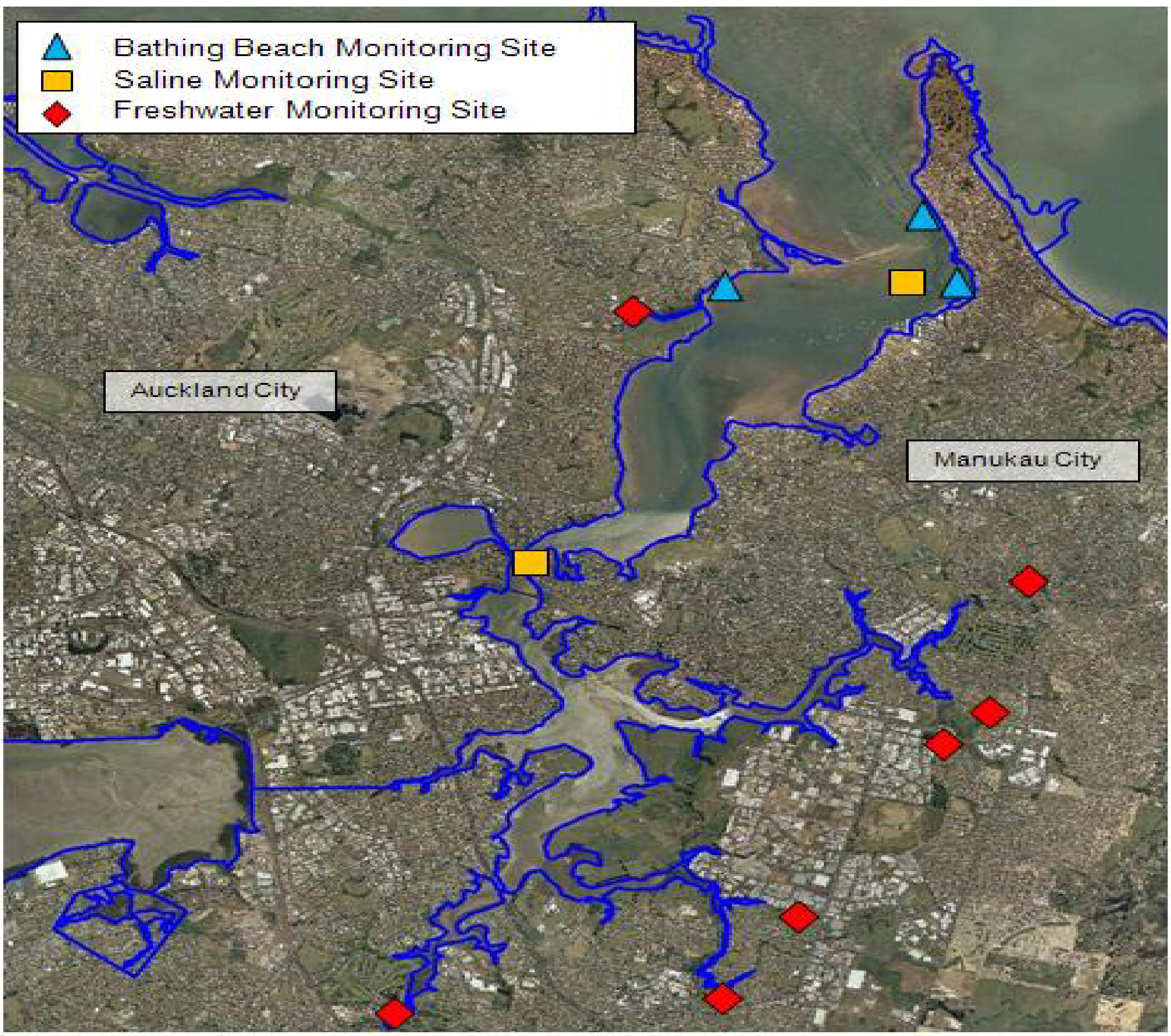


4.1.1 WATER QUALITY MONITORING SITES

A number of different entities undertake regular Water Quality Monitoring across the Tamaki River area as shown in Figure 3 below. These are:

- Manukau City Council – Beach water quality at the Bucklands Beaches (Bathing Season only)
- Auckland City Council – Beach water quality at the Point England beach (Bathing Season only)
- Auckland Regional Council
    - Tamaki River – Buoy No.7 – Saline
    - Tamaki River – Panmure Bridge – Saline
    - Omaru Creek – Taniwha Street – Freshwater
    - Pakuranga Creek – Botany Road - Freshwater
    - Pakuranga Creek – Guys Road - Freshwater
    - Pakuranga Creek – Green Mount Reserve - Freshwater
    - Otara Creek – Kennell Hill - Freshwater
    - Otara Creek – East Tamaki Road - Freshwater
    - Otaki Creek – Middlemore Crescent - Freshwater

Figure 3 – Water Quality Monitoring Sites



4.2 BATHING BEACHES

Within the Tamaki River catchment there are three designated bathing beaches; Point England Beach (within the Tamaki North Catchment), Little Bucklands Beach and Big Bucklands Beach (Manukau City Council area). These are shown below in Figure 4.

Figure 4 – Bathing Beaches

4.2.1 BATHING WATER STANDARDS

The New Zealand Bathing Water Standards are set out by the Ministry for the Environment (MFE) in the Guidelines for Recreational Water Quality (2003). These provide guidelines for the monitoring and management of marine bathing waters using three levels of action (see Table 1 below).

Table 1 – Marine Waters – surveillance, alert and action levels

Mode	Standard
Surveillance/Green Mode	No results from routine weekly samples record greater than 140 *enterococci* per 100mL
Alert/Amber Mode	Sampling regime is increased to daily, if samples exceed more than 140 *enterococci* per 100mL. Investigations are undertaken to identify the possible sources of contamination/pollution.
Action/Red Mode	The bathing waters are considered unsuitable for recreation and the public warned, if **two consecutive** daily samples confirm greater than 280 *enterococci* per 100mL.

Auckland City Council and Manukau City Council currently undertake regular water quality sampling of the bathing waters using the above guidelines during the defined Bathing Season (5 November to 23 April).

Where a sample is found to exceed 140 *enterococci* per 100mL then another sample is obtained within 24hrs where practicable.

The Auckland Regional Plan: Coastal (ARC 2003) indicates that the ARC believes wastewater networks should be managed so that Bathing Beaches are impacted by no more than two separate events per annum where public warnings are required (Red Mode).

4.2.2 BATHING WATER – MICROBIOLOGICAL ASSESSMENT CATEGORY

Further to weekly sampling, each Bathing Water is categorised based on its performance over the last five years. The categories are summarised in Table 2.

Table 2 – Marine Waters – Microbiological Assessment Category

Category	Standard
A	Sample 95 percentile <= 40 *enterococci*/100mL
B	Sample 95 percentile 41-200 *enterococci*/100mL
C	Sample 95 percentile 201-500 *enterococci*/100mL
D	Sample 95 percentile > 500 *enterococci*/100mL

4.2.3 BATHING WATER RESULTS

The results of all the water quality samples taken as part of Bathing Beach surveillance are presented on Auckland City Council's and Manukau City Council's Safe Swim web pages and shown in Table 3.

Table 3 – Summary of Bathing Beach Water Quality for 2008

Beach	Microbiological Assessment Category	Number of Amber Alerts (2003-2009)	Number of Red Alerts (2003-2009)	Comments
Point England	A	0	0	
Big Bucklands	B	5	0	Storage Tank constructed in 2006
Little Bucklands	B	10	1	Storage Tank constructed in 2006

These results should be compared to the general Tamaki River quality at the key saline sites, the results of which is presented in Table 4 below.

Table 4 – Summary of Tamaki River (saline) Microbiological Quality

Location	Microbiological Assessment Category	Number of Amber Alerts (2003-2009)	Number of Red Alerts (2003-2009)	Comments
Buoy No.7 (surface)	A	0	0	
Buoy No.7 (bed)	B	0	0	Results for 2003-2005 only
Panmure Bridge	B	9	0	

None of these sites are re-monitored the following day after amber alerts – so no red alerts can ever be reported.

POINT ENGLAND BEACH
Point England Beach was closed on 4 March 2009 after construction works led to direct overflow of wastewater to the Omaru Creek. This was not identified by the Bathing Water sampling programme.

LITTLE BUCKLANDS AND BIG BUCKLANDS BEACHES
Both of these beaches appear to suffer from poorer water quality than Point England Beach. Manukau Water Limited have recently constructed (2006) a storage tank in between both beaches. Since this has been constructed there has been 1 amber alert at Big Bucklands and 1 red alert at Little Bucklands.

4.3 RIVER WATER QUALITY

The Tamaki River is served by five major urban creeks, as listed below:

- Pakuranga Creek
- Otara Creek
- Otaki Creek
- Otahuhu Creek
- Omaru Creek

General river quality is defined by chemical and biological factors including the level of organism it can sustain. Auckland Regional Council monitor the tributaries within the study area against the following thresholds for suitability:

Table 5 - River Quality Thresholds

Parameter	Suitability thresholds for particular uses	
Suspended solids		
Turbidity	No more than 2 NTU	Contact recreation (e.g. swimming)
Black Disc visibility	No less than 1.6 meters	Aesthetics
Biochemical oxygen demand (BOD_5)grams of consumed oxygen per cubic meter of water	No more than 12 g/m^3(filtered water sample)	Contact recreation
	No more than 35 g/m^3(unfiltered, total BOD_5)	Aesthetics
Dissolved reactive phosphorus (DRP)	No more than 1530 mg/m^3	Contact recreation
		Aesthetics
		Preventing algal growth
Dissolved inorganic nitrogen [2](DIN)	No more than 40-100 mg/m^3	Contact recreation
		Aesthetics
		Preventing algal growth
Nitrate - nitrogen (NO_3 -N)	No more than 30,000 $mg/m^3$for	Stock water supply
	No more than 10,000 $mg/m^3$for	Human consumption

Ammoniacal nitrogen[3](NH_4-N)	Suitability varies with temperature and pH	Aquatic ecosystems
Dissolved oxygen (DO)	No less than 80%	Aquatic ecosystems
pH (acidity/alkalinity)	Acceptable within the range 6 - 9 (i.e. slightly acidic to moderately alkaline)	Aquatic ecosystems
		Water supply

From National Water Quality Network (Ministry for the Environment)

Additionally where there is an expectation of contact recreation or swimming then the river is also monitored for *E. coli* against the Guidelines for Recreational Water Quality (Table 6).

Table 6 – Freshwater – Microbiological surveillance, alert and action levels

Mode	Standard
Surveillance/Green Mode	No single sample greater than 260 *E. coli* per 100mL
Alert/Amber Mode	Single sample greater than 260 *E. coli* per 100mL
Action/Red Mode	Single sample greater than 550 *E. coli* per 100mL

The ARC monitor for E. coli at the locations presented in *Table 7* and the results from 2003 to 2009 are included.

Table 7 – Summary of Freshwater Quality for 2003-2009

Creek	Sampling Point	Total Samples	Number of Amber Alerts (2003-2009)	Number of Red Alerts (2003-2009)	Median Count	Median Count Alert Level	95%ile Count	Maximum Count
Pakuranga	Botany Road	63	58	48	1,900	RED	17,900	64,000
Pakuranga	Guys Road	63	21	15	155	Green	2,690	25,000
Pakuranga	Greenmount Reserve	63	40	25	420	AMBER	4,880	12,000
Otara	East Tamaki Road	63	60	50	1,900	RED	95,100	510,000
Otaki	Middlemore	63	59	50	2,600	RED	46,500	700,000
Omaru	Taniwha Street	63	62	55	2,900	RED	17,900	120,000

The data shows significant *E. coli* counts across all of the monitored freshwater tributaries to the Tamaki River with median counts generally above the amber and red alert levels defined in the Guidelines for Recreational Water Quality. This shows that these creeks are generally unfit for contract recreation.

In addition to *E. coli* the two important water quality indicators are Ammonia and Dissolve Oxygen (DO) and are discussed below.

4.4 AMMONIA

Ammonia is a toxin that can readily affect marine and freshwater organisms. It is non-persistent (breaks down readily through nitrification) and does not accumulate in affected organisms.

Ammonia is measured as 'total ammonia' which consists of ionised ammonium (NH_4) and un-ionised ammonia (NH_3). The toxic affect of ammonia is linked to the pH and temperature at the time. The higher the pH the less ammonia is required achieve toxic levels. Assuming a conservative condition of a pH of 8.2 this provides a trigger level for total ammonia (N) as 0.620mg/l

Table 9– Summary of Total Ammonia (N) 1999-2009 (mg/l)

Creek	Sampling Point	Total Samples	No. Samples Above Trigger Level	Median (mg/l)	Median t Alert Level	99%ile (mg/l)*	Maximum Count
Pakuranga	Botany Road	117	0	0.050	Green	0.163	0.300
Pakuranga	Guys Road	117	0	0.048	Green	0.212	0.271
Pakuranga	Greenmount Res.	117	0	0.143	Green	0.403	0.499
Otara	East Tamaki Road	117	4	0.053	Green	2.632	6.700
Otara	Kennel Hill	116	0	0.040	Green	0.244	0.606
Otaki	Middlemore	116	2	0.065	Green	1.536	5.400
Omaru	Taniwha Street	117	2	0.105	Green	0.745	1.090

* *Percentiles calculated from full sample set*

Overall the creeks perform well showing limited total ammonia issues. The Otara Creek at East Tamaki Road is the worst performing of the creeks.

4.5 DISSOLVED OXYGEN

Dissolved Oxygen (DO) is a fundamental requirement for aquatic organisms. Reduced levels of DO can kill organisms or stress them and increase their susceptibility to other pathogens and toxins.

ARC samples are taken in parts per million (ppm). It has been assumed that the freshwater conversion to mg/l is 1.0.

Table 8 – Summary of Dissolved Oxygen 1999-2009 (mg/l)

Creek	Sampling Point	Total Samples	Conversion ppm to mg/l	Median (mg/l)	1%ile (mg/l)*	5%ile (mg/l)*	Minimum (mg/l)	Maximum (mg/l)
Pakuranga	Botany Road	115	1.0	11.6	7.94	8.97	7.50	17.0
Pakuranga	Guys Road	115	1.0	7.6	0.92	1.49	0.42	16.91

Pakuranga	Greenmount Res.	115	1.0	7.5	4.19	4.94	2.27	10.60
Otara	East Tamaki Road	116	1.0	9.6	6.13	6.98	5.98	14.90
Otara	Kennel Hill	117	1.0	7.3	1.26	2.68	1.20	15.10
Otaki	Middlemore	116	1.0	7.2	2.60	3.35	1.39	12.03
Omaru	Taniwha Street	117	1.0	6.4	1.85	3.20	1.30	10.15

**Percentiles calculated from full sample set*

Table 8 demonstrates that a number of the creeks have very little DO reserves. It should be noted that DO measurements can be sensitive to the location of the sampling point and to air entraining structures such as weirs or waterfalls. They can also be sensitive to nearby pollution that removes DO from the water in the local vicinity.

The results indicate that a number of stretches of Creek would struggle to support Cyprinid fish.

4.6 RECREATIONAL USE

The Tamaki River is regularly used for recreational purposes such as sailing, kayaking and windsurfing. The Panmure basin is used for dingy sailing.

4.7 SHELLFISH

The Tamaki River has extensive shellfish beds (due to the large inter-tidal mudflats along the Estuary. There are no commercial shellfish operations but there will be cultural expectations for recreational shellfish harvesting. The shellfish in the area generally consist of:

- Pupu–*Amphibola crenata*,
- Cockles – *Austrovenus stutchburyi,*
- Pacific Oysters-*Crassostrea gigas, and*
- Speckled Whelks-*Cominella adspersa*),

The Tamaki Estuary, River and tributaries is not classified (by the Ministry for Agriculture and Food) for Human Consumption (Regulation 48) as a Shellfish Growing Area (latest information April 2009). Table 9 below provides Shellfish gathering Bacteriological guideline values.

Table 9 –Shellfish Waters – Gathering Bacteriological guideline values

Category	Standard
Permitted	Median value of <= 14 (Most Probable Number – MPN) *Faecal coliform* per 100ml and not more than 43 MPN/100 ml in more than 10% of samples.
Not permitted	Median value of > 14 (Most Probable Number – MPN) *Faecal coliform* per 100ml and more than 43 MPN/100 ml in more than 10% of samples.
RISK?	Despite suitable samples the standards also require the 'level of risk' of contamination should be considered.

The freshwater tributaries discharging to the Tamaki River are not sampled (WQ) for *Faecal Coliform* but concentrate on *E-Coli* in order to test compliance with the Freshwater Guidance. Available information indicates that there is, at times, a high *E-Coli* loading in the Tamaki Rivers principle tributaries. The high levels of *E-Coli* could be due to stormwater and or wastewater discharges.

Faecal Coliform are tested for and monitored at three sites within the Tamaki River environs, including the Otara Creek. The results presented in Table 10, show that although water quality improves considerably between the Panmure Bridge and Buoy No. 7 sites, the Tamaki River generally fails the Shellfish Water Guidelines.

Table 10 – Summary of Shellfish Water Quality for 2008

Sampling Point	Median MPN (2003-2009)	90% ile MPN (2003-2009)	Max Value (MPN)	Result	Comments
Otara Creek - Kennell Hill	1,400	3,820	7,000	FAIL	7 samples (in 2008 only)
Tamaki River – Panmure Bridge	49.5	1,100	13,000	FAIL	64 samples (2003-2009)
Tamaki River – Buoy No. 7 (surface)	4	105	800	FAIL	56 samples (2003-2009)
Tamaki River – Buoy No. 7 (bottom)	4	50	130	FAIL	30 samples – not available after 2005

The Otara Creek sample history is too limited to draw much from the results; however it does raise the question of the impact of the tributaries on the Tamaki River and the nature and source of this pollution. The Tamaki River itself generally meets the median target between 2003 and 2009. However, it does not meet the 10 percentile standard and does occasionally register some very high *Faecal Coliform* counts.

It is unclear whether the high *Faecal Coliform* counts experienced in the Tamaki River estuary are due to local or upstream pollution or a mix. It may be possible for general pollution in the Hauraki Gulf to be carried into the estuary through wind, tide or current. However, given the lower readings at Tamaki Buoy No.7 this would be relatively minor compared to upstream sources.

5 SUMMARY OF SAMPLING RESULTS

5.1 SUMMARY

A review of the water quality results undertaken, indicate bathing beach water quality of Point England Beach, Little Bucklands Beach and Big Bucklands Beach complies with the Auckland Regional Plan: Coastal (ARC 2003) during the summer monitoring and that the risk to public health is limited. However, the results of the water quality sampling considering that there are frequent overflows from the Tamaki North wastewater catchment close to the Point England Beach water quality sampling point confirms more investigation is required.

The following is a number of possible reasons for the low failure rate of the ARC water quality monitoring at Point England beach:

- Infrequent sampling immediately after an overflow event
- Sampling location in relation to the Omaru creek mouth (Flows from the Omaru creek may flow past the existing sampling point)
- Bacteria kill rate upon reaching the saline environment
- New Zealand's high UV

To date existing information has been gathered and analyzed based on data that has been collected from various sources throughout the past five years. It is evident that the review of the available data has highlighted some gaps that will be relatively simple to overcome. The following sections provide a summary of the next steps to be undertaken and will allow additional confidence in the findings.

5.2 STRATEGIC SAMPLING PROGRAMME

The sampling data that has been reviewed to date has been extremely useful. However, it must be noted that due to the locations of the sampling equipment (usually derived through access and health and safety issues) some of the results may require refinement.

Dry and wet weather sampling should be undertaken upstream and downstream of the SSO discharge points, together with dry and wet weather sampling of the fresh water inputs into the Tamaki River from the Manukau catchment. This will allow the following to be confirmed:

- Presence of faecal matter during dry weather – If there is faecal bacteria present during dry weather; it indicates a problem that may not be related to the SSOs.

- Observing the faecal count upstream of the SSO discharge points during wet weather will allow assessment of upstream discharges in relation to the faecal count downstream of the SSOs and its subsequent effect on the bathing water standard.

- A clear understanding of the faecal count in the upstream Manukau tributaries during wet weather events will allow a holistic assessment of the source of bathing water failures. From this point, we can then assess the effect of the SSOs in isolation against the bathing water standard assuming a ‘clean’ input from Manukau.

5.3 DNA MARKING

Watercare have recently undertaken DNA sampling of faecal matter. This allows assessment of whether faecal matter has been derived from humans or other sources. As a minimum, the faecal matter that is collected as part of the sampling strategy should be tested to confirm that it has been derived from humans. It should be noted that the Manukau Rivers that perform badly in terms of sampling results flow through separate wastewater and stormwater catchments and should only have a minimal SSO input.

However, should the Manukau samples prove to be from human sources, then further investigation will be required. Watercare will assess planned projects on removing any human faecal matter from the river to meet the required bathing standards, should the results of our ‘clean input’ scenario warrant it.

The results may show that some faecal matter is not human derived and there may be some stormwater solutions required to meet the bathing water standards.

5.4 STORMWATER ASSESSMENT

In addition to a Micro Biological assessment, it may be necessary to assess the effect of heavy metals on the bathing standards and in particular the shellfish population. It may also be necessary to undertake some sediment analysis to assess BOD requirements, although this is often not such an issue in Natural Estuaries. Any stormwater solutions that would help mitigate the conveyance of heavy metals to the estuary would be beneficial but are outside the control of Watercare.

5.5 COASTAL MODELLING

Once the above sampling strategy and desk top study have been completed, a cost benefit analysis should be undertaken to assess the cost of undertaking a coastal modeling exercise versus potential cost savings of CAPEX through storage requirement refinement. Without a coastal model, the wind, tide and decay factors of bacteria cannot be accurately assessed. However, it should be noted that the above work may well provide enough evidence to delay the proposed capital expenditure until further investigations are completed.

Recently in Edinburgh Scotland, over $40M CAPEX was saved by undertaking a coastal modeling exercise of the Portabello catchment. The modelling study confirmed that large storage facilities were not required in the sewer network as the combined bacterial impact from both continuous and intermittent discharges met the standards set out in the Bathing water Directive and the Scottish Environmental Protection Agency (SEPA).

6 CONCLUSIONS

Early conclusions show that the Bathing Beach at Point England has not failed New Zealand Bathing Water Standards since 2003. It is also evident that the upstream Tributaries of the Tamaki River from Manukau are of a particularly poor quality. However, it must be noted that the shellfish standards downstream of the SSO discharge points (Buoy 7) have failed several times during 2008, although it can be argued (see Table 4) that the failure is due to the poor upstream quality that has not been sufficiently diluted at the time of sampling.

It is not clear at this stage if the poor water quality present in the Manukau streams are human derived and further investigation is required through DNA testing.

The high capital expenditure planned for the Glen Eden storage tank may not be appropriate at this stage. Additional investigation is required to assess the Tamaki River holistically to provide a best practicable option for the community and to meet both bathing and shellfish water standards.

Options for consideration in future investigations include staging the construction of the tank to allow funds to be directed to addressing the issues in the upper catchment where significant bacteria levels have been detected.

Further work is required on the DO and ammonia analysis. The low levels of DO (attributed to high BOD) could be a combination of sediment, flow conditions and temperature in the freshwater creeks. Water quality sampling during dry weather would provide more robust conclusions around DO levels versus wastewater input. Low concentrations of ammonia could indicate a low presence of wastewater.

If the poor water quality results are confirmed to be attributed to wastewater overflows then consideration is required to evaluate its impact and a phase 2 UPM approach may be considered.

The next phases of the project are as follows:

- Strategic Sampling Fresh Water and Bathing
- Model Updates (WQ)
- River Boundary Conditions and models
- RIOT analysis (optimized CSO management looking at best location for storage)
- Coastal Model update and simulations

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MWH

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Auckland City Council

Manukau City Council

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