Wairoa Wastewater Discharge Re-Consenting

Natural Hazard Implications

Prepared for

Wairoa District Council

Prepared by

Lowe Environmental Impact

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1 EXECUTIVE SUMMARY

The potential impact of natural hazards on the structure and operation of credible wastewater discharge options at Wairoa is assessed in this report.

From an initial list of 6 broad discharge possibilities**, 4 feasible options** are identified, being:

- To the Wairoa River estuary (as at present);
- To the Wairoa River upstream from the estuary;
- To the ocean, downstream from the estuary; and
- To land, either alone, or in combination with one of the above.

Natural Hazards that could impact on the Wairoa municipal wastewater system and its discharge options are identified as the following:

- Coastal Hazards;
- Rain and its consequences;
- Seismicity; and
- Volcanic hazards.

In conclusion, the natural hazards that are recommended to be addressed further in the consideration of options for wastewater discharge at Wairoa are as follows:

- For any continuing use of the existing estuary discharge, likely future behaviour of the river mouth bar in the context of coastal erosion and sea level rise should be further investigated;
- For any ocean outfall discharge, coastal erosion and the successful management of the mobility of the coast and sea floor would need further detailed consideration;
- For land discharge, the impacts of increasing intensity and frequency of rain storms on reserve storage and land application rates will need to be considered;
- For all discharge options, the combination of increasing rain storm intensity and possible liquefaction damage during earthquakes make upgrades to the reticulation network a matter to be addressed; and
- While tsunamis, rising sea level and volcanoes will probably all occur eventually, the likelihood of them damaging or impairing the operation of the Wairoa wastewater discharge in the next 50 years is low enough not to be giving them priority over other infrastructure maintenance requirements.

2 INTRODUCTION

2.1 Purpose

To identify, and provide a preliminary assessment of the severity and cost implications of, natural hazard exposures relating to each wastewater discharge option considered likely to warrant further investigation.

2.2 Background

The Wairoa municipal wastewater system is managed on behalf of the Wairoa community by the Wairoa District Council. The discharge from the system requires re-consenting and a possible upgrade. Identification and consideration of a range of discharge options will be required. Each of the discharge options to be considered will involve an exposure to natural hazards, to a greater or lesser extent. The management and mitigation of those hazards can be expected to have both a financial impact and an impact on the selection of a best practicable discharge option.

2.3 Scope

This report provides a summary of the natural hazard issues to be taken into account when a decision is made on which discharge options should be investigated further. Issues to be addressed include some or all of the following:

- The identification of coastal hazards applying to the existing discharge facility;
- The identification of flooding and/or erosion hazards applying to credible land treatment options;
- The identification of seismic and associated hazards relating to sewer reticulation;
- The provision of a general outline of the extent and potential severity of each hazard; and
- The identification of potential financial implications of satisfactory management of each hazard.

The report is not intended to provide specific detail, which will be addressed later as the project moves to target a more limited number of discharge options for further consideration.

3 PRINCIPLES

3.1 General

This short section of this report is to describe the framework within which the potential impact of natural hazards is addressed.

3.2 Natural Hazards

These are events or happenings that are outside the normal daily routine of occurrences that people and communities live with; and that have the potential to upset that routine. They range from known and predictable hazards, such as heavy rain, through less likely but nevertheless inevitable events such as earthquakes, and a Pandora's box of wildly improbable but theoretically feasible catastrophes.

Climate Change is addressed separately below. For the purposes of this report, Climate Change is not considered a natural hazard in its own right, but rather as a process that influences the intensity of existing natural hazards.

In this report, the relevant natural hazards are considered as follows;

- Coastal Hazards;
- Rain and its consequences;
- Seismicity; and
- Volcanic hazards.

3.3 Scale and Context

Natural hazards can manifest themselves across a wide range of severities, from comparatively mild events such as a severe unseasonal frost, to widespread devastation from a large tsunami. A principle to be followed here is that hazards that are avoidable or manageable should be avoided or managed, to an extent that is comparable with the resilience of other assets and infrastructure. This helps to ensure that any design, and evaluation, is not distorted within the scope of managing WDC's other infrastructure and assets.

There is no need to engineer a wastewater discharge structure to withstand a magnitude 9 earthquake, if a magnitude 7 earthquake will destroy the wastewater treatment plant that feeds the discharge structure. Similarly, if a road and its associated drains and culverts are engineered to cope with a 50 year return period rainfall event, then it would not be prudent to design a bridge for that road with a flood routing capacity of less than the same 50 year return period flood.

For the Wairoa wastewater system, it would be prudent to design the infrastructure and its operation to a standard that will withstand natural hazards that will also be withstood by most of the rest of Wairoa and its infrastructure. There is no point in designing (and paying for) a wastewater system to such a high standard that it is the last structure standing after whatever cataclysm may possibly occur.

3.4 Discharge Scenarios

Without prejudging the discharge scenario that Council and the community may select as the Best Practicable Option, there are basically seven discharge options that cover all the possibilities, as follows:

- To the Wairoa River estuary, as at present;
- To the Wairoa River upstream from the estuary;
- To the ocean beyond the estuary;
- To land;
- To some other receiving environment;
- Some combination of some or all of the above; and
- Abandonment of the reticulated sewer and a return to individual onsite wastewater discharges.

At this time there is no "some other receiving environment" that is known or worthy of further consideration. Similarly, abandonment of the reticulated sewer is not considered to be a credible option; there were very good public health reasons to install the sewer in the first place, and those reasons are as applicable now as they were 70 years ago when the sewer was installed.

That leaves:

- the estuary;
- upstream from the estuary;
- downstream from the estuary (ocean); and
- land.

These options can be evaluated alone or in combination, as the discharge scenarios to be considered in the context of natural hazards.

4 CLIMATE CHANGE

4.1 General

Largely uninformed public debate continues internationally, as well as in New Zealand, about whether or not world climates are changing, whether or not this will lead to changes in sea level, whether or not the potential changes are caused by the activities of mankind, and whether or not there is anything that mankind can or should do to arrest the potential changes.

However, the only structured, scientifically credible evidence is that climate is changing. A steady warming of the atmosphere is expressed in melting glaciers and polar icecaps, and this must be expected over time to lead to significant rises in sea level; not just at Wairoa, but throughout the world. Increasing CO_2 concentrations in the atmosphere and increasing air temperatures are matters of fact, not opinion, and whether they are causes, or effects, of climate change is irrelevant; they are happening. Climate Change should be expected to have an increasing influence on the potential severity of existing natural hazards, and the effects of these should be considered in the context of the Wairoa Wastewater Re-Consenting project.

4.2 Sea Level Rise

An average rate of sea level rise of 1.8 mm/year has been measured over the duration of the 20^{th} century, and if this rate continues, then over the next 50 years (to 2066) a further rise of 90 mm should be expected. There is also the possibility that the rate at which glaciers, and more particularly polar ice caps, will melt will accelerate and happen more quickly than has happened up until now. Under this scenario, sea level could be expected to rise by between 3 and 5 mm/year, and over a 50-year time span this could equate to a rise of 150 to 200 mm. Note that these sea level rise predictions are readily accessed from the Internet, and are provided here as a general indication of likely future circumstances. Further detailed examination of the issue, including a literature search, may be necessary if favoured wastewater discharge options include elements at potential risk from sea level rise.

If a worst case for sea level change is a rise of 200 mm over the next 50 years, then sea level change alone would **not** be likely to make any significant difference to the integrity or functioning of the Wairoa sewer outlet. Over a longer term, perhaps a century or two, that rate of sea level rise could be expected to start to influence the discharge, especially if the rate of change increases sharply. However, by the time such sea level changes occur, Wairoa, New Zealand, and the world will have more pressing concerns than interference with the Wairoa municipal wastewater discharge. This includes operational limitations that may be imposed on Wairoa's sewer reticulation.

In summary, it would be wise to expect that sea level will rise, but not to such an extent as to cause significant and direct problems for the Wairoa wastewater discharge during the design life of the existing, and potentially foreseeable discharge infrastructure.

4.3 Changing Weather Patterns

Besides warming temperatures and melting glaciers and polar ice caps, Climate Change has other more significant and earlier implications for the Wairoa wastewater discharge. Expectations from competent meteorological and climatological specialists are that there will be a transition to wilder fluctuations in weather conditions than we have been accustomed to (Ministry for the Environment, mfe.govt.nz/climate-change). Droughts should last longer and be more frequent, at least in dry parts of the country. Rain storms should be heavier and more frequent, and floods should be expected to be more severe and more damaging. Existing conventions for the calculations of flood event return periods (50 year flood, 100 year flood) will probably need to be revised upwards, in due course.

Wairoa already experiences heavy rainfall from time to time, which causes significant damage; financial support from NZ Transport Agency to WDC for road repairs following rainstorms and floods is among the highest to any Council in the country. It would be prudent to expect that, over the design life of the wastewater discharge infrastructure (nominally 50 years), damaging rainstorms and floods should be more severe, and more frequent, than has been experienced in the past.

5 COASTAL HAZARDS

5.1 General and Planning Provisions

Coastal Hazards are addressed in Chapter 15 of the Hawke's Bay Regional Coastal Environment Plan ("RCEP"). The RCEP identifies 3 Coastal Hazard Zones, which are shown on Figure 1 in Appendix A, and which are defined as follows:

*"**Coastal Hazard Zone 1 (CHZ1)** means an area identified on the planning maps which is land assessed as being subject to storm erosion, short-term fluctuations and dune instability and includes river mouth and stream mouth areas susceptible to both erosion and inundation due to additional hydraulic forcing of river or estuary systems. For the purposes of this Plan, it extends a distance of 200 m seaward from its inland boundary.*

***Coastal Hazard Zone 2 (CHZ2)** means an area identified on the planning maps which is land assessed as being potentially at risk up to 2100 due to long term rates of coastal erosion and at some locations, may also include areas assessed as being potentially at risk of sea water inundation in a 1 in 50 year combined tide and storm surge event. It includes allowance for sea level rise, but does not include land within Coastal Hazard Zone 1 or Coastal Hazard Zone 3.*

***Coastal Hazard Zone 3 (CHZ3)** means an area of land assessed as being potentially at risk of sea water inundation in a 1 in 50 year combined tide and storm surge event, and includes allowance for sea level rise, but does not include land within Coastal Hazard Zone 1 or Coastal Hazard Zone 2."*

It can be seen from Figure 1 that CHZ1 includes the river mouth, beach and sand bar in the Wairoa locality, but does not include any area with municipal wastewater system assets, with the marginal exception of the existing estuary discharge diffuser.

CHZ2 is not represented in the Wairoa locality.

CHZ3 covers a wide area of the lower reach of the Wairoa River upstream as far as Outram Street, which is the inland limit of the Coastal Marine Area to which the RCEP applies. The hazard zone covers only the river area adjacent to the town, but downstream from Colin Street it extends onto land west of the river and south of the town, including Scott Street and all flat land from Colin Street down to the estuary.

From the CHZ definitions above, it is clear that "Coastal Hazards" include storm erosion, inundation during combined storm and tide events, and dune instability.

5.2 Coastal Erosion

Coastal erosion at Wairoa involves an intricate balance of opposing forces. On the one hand, a geologically rapid uplift of the land, and an accelerated rate of sediment transport by the Wairoa River of erosion debris from a vulnerable catchment following widespread forest clearance, can be expected to push new land out into what is presently the sea. On the other hand, the soft papa of the coastal hills and the soft sand and gravel of the beach and low terraces offer little resistance to the erosion of the coastline during heavy southerly storms.

That balance may be expected to move with climate change; both rising sea level and storms of greater frequency and severity are likely to increase the rate at which the coastline retreats inland.

Coastal erosion in its simplest form is the permanent consumption of the land by the sea. Neither the actual current rate of coastal erosion, nor projected rates as a result of climate change have been assessed here; specialist assessment of these could be considered later if necessary.

5.3 Inundation

This is the more-or-less temporary flooding of land. It could potentially happen in Wairoa, with a combination of a high tide, a closed river bar, a strong southerly storm, and a flood in the river. A flood alone can cause inundation, but the coastal influence might be expected to cause a more severe problem in the area downstream from Colin Street.

5.4 Assets at Risk

In the context of the existing Wairoa wastewater discharge, there is only one asset near enough to the coast to be potentially affected by coastal erosion, being discharge pipe and diffuser located in the river estuary. The wastewater treatment plant ("WWTP") on Pilot Hill is likely to be sufficiently elevated and inland not to be affected.

The WWTP is located 600 m north from the current coastline, and must be considered most unlikely to be directly affected by coastal erosion in the next century, due to both its distance from the current coastline and its elevation.

The discharge structure in the river estuary is located some 400 m north of the current coastline. It consists of a concrete pipeline, extending south-eastwards from the south end of Kopu Road, a distance of about 80 m out into the Wairoa River estuary. It is also unlikely to be directly eroded by the sea in the foreseeable future, despite this it does suffer from flow restriction as a result of silt and debris accumulation. However, its function depends on the river mouth through its sand bar remaining open, and any significant increase in the rate of coastal erosion may be expected to see the sand bar migrate inland, changing the bar behaviour in ways that are not yet evident.

Inundation is not as permanent as erosion, but the sewer main from Kitchener Street down to and including the Fitzroy pump station are on land within the CHZ3 zone, and liable to be inundated in a 1-in-50-year storm and tide event.

5.5 Implications for Existing Reticulation and Pump Stations

Existing reticulation and pump stations are not likely to be affected by coastal erosion in the next 100 years.

Reticulation, in the form of the sewer main from the town to the Fitzroy pump station, is unlikely to be physically disrupted by inundation, but does have the potential to be filled, and have flows restricted, by silt-laden flood waters if those waters got access into the sewer, such as through the pump station.

The Fitzroy pump station is also unlikely to suffer physical disruption as a result of inundation, but dirty water could still potentially make a mess of the electric supply and controls, disrupting the function of the entire sewer system until it could be got back into service.

These matters are of operational caution rather than re-consenting issues.

5.6 Implications for Existing Discharge Infrastructure

The risk to the physical integrity of the discharge structure in the next century from direct coastal erosion should be considered small. However, the risk to the function of the existing discharge structure posed by potential changes to bar opening and closing behaviour is considered to be the most significant coastal erosion hazard to existing infrastructure. If the use of the existing discharge structure is to be continued, then more detailed consideration of future bar behaviour would be prudent.

5.7 Implications for an Ocean Outfall

As noted in Section 3.4 above, one of the credible discharge options for consideration is a discharge downstream from the Wairoa River estuary, that is an ocean outfall directly into the sea.

Such a discharge would involve the installation of a pipeline from the WWTP, down the hill to the shore of the estuary, then underground (and under water) across both the estuary and the river mouth bar, then on or under the sea bed for an as-yet unspecified distance out to sea, finishing at a heavy, anchored discharge outlet. Such a pipeline would need to cross through any active zone of coastal erosion, and would need to be either resistant to, or buried well below the influence of, sand bar and sea bed sediment movements.

The following quote from The New Zealand Pilot (NZP, 1956) describes the Wairoa coast from a mariner's viewpoint.

"*Wairoa River is a considerable stream, but its entrance is narrow, difficult, and has a shifting bar; the tidal streams are strong, and in southerly weather it is dangerous to approach. Vessels can anchor off the Wairoa River… in fine weather, but a heavy ground swell sets into the bay. On the approach of a southerly wind the sea sometimes breaks in a depth of 12 fathoms (21.9 m).*"

While the reference cited is both foreign and elderly, there is no reason to doubt that the above information remains relevant. The references to the shifting bar and the sea breaking in (nearly) 22 m depth are indications of the mobile, high energy environment through which the pipeline to an ocean outfall would need to be installed and sustained. Durable structures have been successfully installed in more difficult situations than this, but the cost of doing so for a Wairoa wastewater discharge, while not investigated here, would seem to be substantial.

5.8 Implications for a Land Discharge

Provided the land that might be selected for wastewater application is not directly adjacent to the coast, or on flood-prone land adjacent to a river mouth, coastal hazards should have **no** implications for such a discharge.

6 RAIN AND ITS CONSEQUENCES

6.1 General

As described in Section 4.3 above, one of the expected consequences of Climate Change will be that damaging rainstorms and floods should be more severe, and more frequent, than has been experienced in the past.

6.2 Assets at Risk

The main impact of any increasing intensity of bad weather on the Wairoa wastewater system is likely to be an increasing exposure to stormwater entry into the sewer system. There is currently an ongoing and significant occurrence of stormwater overloading of the sewer. While the sewer network, treatment plant and discharge infrastructure have the capacity to cope with dry weather, and even mildly wet weather inflows, leaks and other inputs have developed over the last 70 years that lead to overloads, as described in report A1I1. These overloads would currently appear to result in unacceptable overflows of sewage-contaminated stormwater. More severe bad weather has the potential to make this existing situation worse without modification to the existing reticulation.

6.3 Implications for Discharge to Water

Within limits, wastewater discharges to rivers or the sea have an in-built capacity to cope with brief increases in stormwater loading, provided the pipework has the physical capacity to handle the sharply increased flows. Storms can (and do) load up sewers with stormwater, but this effectively dilutes the sewage, which in turn is discharged into a flood-swollen river (or the sea). The river or the sea in these circumstances already carries a high load of contaminants; and in terms of measurable effects, the addition of a modest amount of sewage to a flooding river or to the sea during a storm makes little difference to what is already there.

However, these overflows do not only occur in discrete, out-of-the-way places where they may not be noticed. Overflows can, and do, throw off manhole covers and discharge stormwater, with identifiable items of sewage disgorged into streets and even private properties within Wairoa. As identified in Report A1I1, there is an existing need to identify and eliminate the stormwater entry points to the sewer network.

6.4 Implications for Discharge to Land

6.4.1 Wastewater Volumes

As described in Section 3.4, a wastewater discharge to land is one of the credible options to be considered for Wairoa. If a wastewater discharge is managed onto land as irrigation, rather than discharged into a river or the sea, then the volume of the discharge becomes much more critical than is the case for a discharge to water. When it is raining hard, the land will be too wet to have any wastewater applied to it (irrigated onto it) without causing unacceptable ponding and run-off. If the wastewater can't be irrigated (at least not right away) then it has to be stored, and ponds for this purpose need to be large, carefully lined so they don't leak, and can be expensive. Storms of increasing severity and frequency should be expected to accentuate both the need to provide adequate storage, and the need to minimise stormwater entry to the sewer system in order to minimise the expensive storage requirement.

The implication for Wairoa is that if a land discharge system is decided upon, then there will need to be one or more of the following additional commitments:

- Either a major sewer network upgrade to substantially reduce the entry of stormwater into the sewer; **and/or**
- A large capacity wastewater storage facility, to be able to contain not only the normal wastewater flow from a population of 4,000 people, but also all the stormwater that currently leaks into the sewer network; **and/or**
- A facility for the contingent discharge of wastewater beyond the capacity of the storage facility, into either the Wairoa River or the sea.

The financial implications of these measures have not been assessed, but indicative estimates will need to be available to assist community consultation and the process of selection of a Best Practicable Option.

6.4.2 Irrigation Considerations

Many New Zealand communities have become accustomed to sewage discharges to rivers or to the sea taking whatever flow of wastewater may need to be discharged at the time. A major difference between such surface water discharges and any land discharge is that land discharge (i.e. irrigation) can only take place some of the time. If the land is already wet, whether from rain, from flooding, or from the most recent irrigation event, then irrigation cannot take place.

In order to minimise wetness-related disruptions to wastewater irrigation, the land to be irrigated needs to be carefully selected, preferably avoiding low-lying flood plains and wetlands, and preferring sites with easy contour, and soils with a high capacity to assimilate applied wastewater. Steeper sites can be irrigated, but they carry risks of the irrigation triggering erosion, or of erosion damaging the irrigation infrastructure.

The prospect of heavier and more frequent rain storms is a further consideration to be taken into account when assessing any land discharge proposal. It is expected that the impact of Climate Change and its rainfall implications on wastewater irrigation can be satisfactorily met by an irrigation design that makes a generous allowance for the area of land to be irrigated, and provision for a conservative hydraulic application rate. In this way, an irrigation system may be expected to cope with extended periods of wet weather, provided it is backed up by the necessary provision of an adequate storage facility.

7 SEISMICITY

7.1 General

Seismicity means earthquakes and the things that happen as a result of them. The potential impacts of earthquakes in the Wairoa locality include the following:

- The direct rupture of the land surface along a fault line;
- A differential alteration of land levels on either side of a fault line;
- General shaking of the ground and structures;
- Liquefaction of saturated sandy sediments; and
- Tsunami or tidal wave.

A large active fault zone extends north-east to south-west along the Hikurangi Trench off the east coast of the North Island, and continuing at depth beneath the entire East Coast area, including Wairoa. It is part of a larger tectonic subduction zone many thousands of kilometres long, which is one of the world's major active structural features. It has generated earthquakes, large and small, for many millions of years, and can reliably be expected to continue to do so.

7.2 Direct Surface Rupture

This involves differential movement of the land on either side of a fault line at the earth's surface, and could be expected to disrupt roads, power lines, and sewers that happen to cross the fault line. Such an event has a low likelihood of occurring; most fault movements happen at depth and do not result in a direct rupture at the surface. Nevertheless, such ruptures can, and do, occur, as has recently occurred in Kaikoura.

It is not possible to predict with any certainty where and when such ruptures will take place, and if they do, the normal response would be to repair whatever has been broken, and to carry on with business as usual. There does not appear to be any preventive measure that can practicably be adopted to avoid the very slim likelihood of damage in such an event.

7.3 Differential Alteration of Land Levels

One potential consequence of a direct surface rupture is the changing of relative land surface levels on either side of the rupture. The Murchison earthquake in 1929 disrupted the main road along the Buller Gorge, lifting the road on one side of the rupture by several metres. Similarly, the Edgecumbe earthquake in 1987 saw a rupture cut across a country road, lifting one side by several metres; a driver in a Mini had the misfortune to drive across the drop a few moments later. And most recently at Kaikoura a large area of coastal seabed was uplifted by 1 to 2 metres along a more-or-less straight fault line.

As with surface ruptures above, the likelihood of such an occurrence in any given locality is low. Its effect could potentially be to disrupt the down-grade flow of wastewater, should it cross a sewer line. And as above, there does not appear to be any preventive measure that can practicably be adopted to avoid the very slim likelihood of damage in such an event.

7.4 General Shaking

General shaking is the most likely result of any earthquake of magnitude 4 or more, centred anywhere within several dozen kilometres, vertically or horizontally, of Wairoa. Such shaking can be expected to range from barely detectable to highly destructive, with stronger quakes likely to bring down buildings, bridges, and hillsides. Such earthquakes have occurred in Eastland since time immemorial, and while their timing and location are unpredictable, they must be regarded as inevitable.

A severe shake at Wairoa could be expected to damage property and infrastructure in a manner that many in the community may regard as having a higher priority to repair than the sewer. Nevertheless, national and international experience is that failure of sanitation systems during natural disasters can lead to acute public health problems that can only be rectified with the re-instatement of the sanitary infrastructure.

A severe shake at Wairoa could potentially damage not only the wastewater pump stations but also their power supplies. It could potentially damage the pond walls and flow control equipment at the WWTP. Building Code provisions to guide the construction of buildings to minimise earthquake damage in New Zealand stand up well to any international comparison, and continued adherence to these is probably the best and most appropriate approach to securing the Wairoa wastewater system against at least some of the potential earthquake hazards.

7.5 Liquefaction

This term was largely unknown to the general public before the Christchurch earthquakes of 2011, but is now part of most people's vocabulary. It arises from the action of general shaking (as described above) on saturated soft sandy sediments, causing them to become fluid for a short period of time, and to lose their cohesion and load-bearing strength.

At Wairoa, much of the sewer reticulation and private connections to it lies within un-compacted sands near and below water level in the adjacent river. That these sands are saturated and allow water to move rapidly through them is known to be one of the contributing factors to the high rates of stormwater inflow to the sewer system.

There is a potential for strong shaking to lead to liquefaction of this sand beneath the town, and for the sewer reticulation to be disrupted and broken. It is relevant that in the nearly 70 years since the reticulation was installed, it has not been disrupted by liquefaction, and this should provide some measure of confidence going forward. However, it by no means exempts the current reticulation from being impacted on by liquefaction.

Modern synthetic pipes are expected to be much more resilient to liquefaction damage than the earthenware pipes and their mortar-cemented joints that used to be standard practice. As lengths of sewer are replaced from time to time, the use of these modern pipes can be expected to reduce the town's exposure to this hazard.

7.6 Tsunami

A tsunami can be generated when a strong earthquake causes the collapse of large volumes of soft sediment down steep undersea gradients. Conditions suitable for such events occur along and adjacent to the Hikurangi Trench off the Eastland coast, and within less than an hour of such an earthquake there is the possibility of a rapid and destructive rise in sea level. There is anecdotal evidence that following the Napier earthquake of 1931 a tsunami ran right across the low-lying land between Taylors Bay and Mahia Beach, between Mokotahi and the higher land behind the Mahia Beach settlement.

While there was startling video footage of the advance of the tsunami in Japan a few years ago, and while it is possible for a tsunami to run some kilometres up a river mouth, the Wairoa sewer system should not be considered to be at any greater risk to this hazard than most other public and private assets in and near the town. The WWTP is high enough above sea level not to be considered as at risk, and with almost all the rest of the sewer system underground it also would be fairly resilient against a tsunami. Bridges and power supplies (including that to the sewer pump stations) would be at greater risk than most of the sewer network.

8 VOLCANIC HAZARDS

8.1 General

There are no volcanoes, active or otherwise, anywhere near Wairoa. There are hot springs at Morere and further north at Te Puia, but while these are indicative of deep heat associated with the underlying subduction zone, they do not indicate any likelihood of a related hazard in the Wairoa area.

The closest active volcanic area to Wairoa is the Ruapehu/Taupo/Tarawera/White Island axis of the Taupo Volcanic Zone, 140 km to the west of Wairoa. The only direct hazard that this volcanism poses to Wairoa is the possibility of ash showers in the event of a major eruption. Both local soil profiles and sea floor sediment cores from off the Eastland coast show significant layers of pumice material, inferred to have come from Taupo and central North Island eruptions. Further, such eruptions into the distant future should be regarded as inevitable, but the time scales involved are in the hundreds, if not thousands, of years.

While volcanic ash showers would pose little direct threat to the Wairoa sewer network or any river or sea discharge facility, they could potentially interfere with a land discharge system, if they were sufficiently severe. However, the likelihood of such an event in any given year may be considered sufficiently small to not need further consideration. If an eruption was sufficiently large to cause wastewater irrigation problems at Wairoa, it would be safe to assume that the community, the Council, and the country would have a wide range of more severe and immediate concerns.

While there is a nominal risk of volcanic activity having an impact on the Wairoa wastewater discharge, its likelihood in any given year is very low. To re-iterate the Scale and Context of Section 3.3 above, it should only be necessary to design the infrastructure and its operation to a standard that will withstand natural hazards that will also be withstood by most of the rest of Wairoa and its infrastructure. In this regard, the potential impact of volcanic activity should be considered very minor.

9 CONCLUSIONS AND RECOMMENDATIONS

From an initial list of 6 broad discharge possibilities**, 4 feasible options** are identified, being:

- To the Wairoa River estuary (as at present);
- To the Wairoa River upstream from the estuary;
- To the ocean, downstream from the estuary; and
- To land, either alone, or in combination with one of the above.

Natural Hazards that could impact on the Wairoa municipal wastewater system and its discharge are identified as the following:

- Coastal Hazards;
- Rain and its consequences;
- Seismicity; and
- Volcanic hazards.

The approach taken to assessing the potential impact of the identified hazards is that it would be prudent to design the infrastructure and its operation to a standard that will withstand natural hazards that will also be withstood by most of the rest of Wairoa and its infrastructure.

Climate Change is expected to lead to a gradual rise in sea level, which **is not expected** to have any significant impact on any of the wastewater discharge options in the next 50 years. It is also expected to lead to heavier and more frequent rain storms, and floods should be expected to be more severe and more damaging, and these effects **are expected** to have an impact on all discharge options.

Coastal Erosion is considered not to pose a threat to the existing WWTP in the next century. While it is also unlikely to affect the physical structure of the existing estuary discharge facility, it may have effects on the river mouth bar that impact on the functioning of the estuary discharge. If the estuary discharge is to be continued, then it is recommended that there should be more detailed consideration of future bar behaviour. Should a coastal discharge be considered, the impact of coastal erosion should be taken into account with any outfall structure.

Changing rainfall patterns are expected to involve increasing intensity and frequency of bad weather. One effect of this on the Wairoa wastewater system is likely to be increasing stormwater entry into the sewer system, increasing the likelihood of contaminated stormwater overflows from the sewer. There are also expected to be significant effects on any land discharge system, relating to the provision of adequate reserve storage capacity, a sufficiently large land treatment area, and a sufficiently low hydraulic application rate.

Earthquakes are an ongoing hazard that has to be accommodated by all public and private assets. The most likely events are the general shaking caused by significant movement on a fault line anywhere within several score of kilometres, vertically or horizontally, of Wairoa. A severe shake at Wairoa could potentially damage not only the wastewater pump stations but also their power supplies. It could potentially damage the pond walls and flow control equipment at the WWTP. Shaking also has the potential to cause liquefaction of saturated sands beneath the town, with consequent rupture of sewer pipes. Adherence to the Building Code and progressive sewer line upgrade with modern synthetic pipes are the prudent way to address these hazards. Tsunamis and direct surface ruptures are also possible results of earthquakes, but the probability of these events having a disproportionate impact on the wastewater discharge system is low.

Volcanic hazards pose a nominal risk to the Wairoa wastewater discharge, but their likelihood in any given year is very low.

In conclusion, the natural hazards that should be addressed further in the consideration of options for wastewater discharge at Wairoa are as follows:

- For any continuing use of the existing estuary discharge, likely future behaviour of the river mouth bar should be further investigated;
- For any ocean outfall discharge, coastal erosion and the successful management of the mobility of the coast and sea floor would need further detailed consideration;
- For land discharge, the impacts of increasing intensity and frequency of rain storms on reserve storage and land application rates will need to be considered;
- For all discharge options, the combination of increasing rain storm intensity and possible liquefaction damage make upgrades to the reticulation network a matter to be addressed; and
- While tsunamis, rising sea level and volcanoes are possibilities, the likelihood of them damaging or impairing the operation of the Wairoa wastewater discharge is low enough not to be giving them priority over other infrastructure maintenance requirements.

10REFERENCES

NZP (1956): *The New Zealand Pilot, 12th Edition, 1958.* Hydrographic Department, The Admiralty, London. 501 pp.

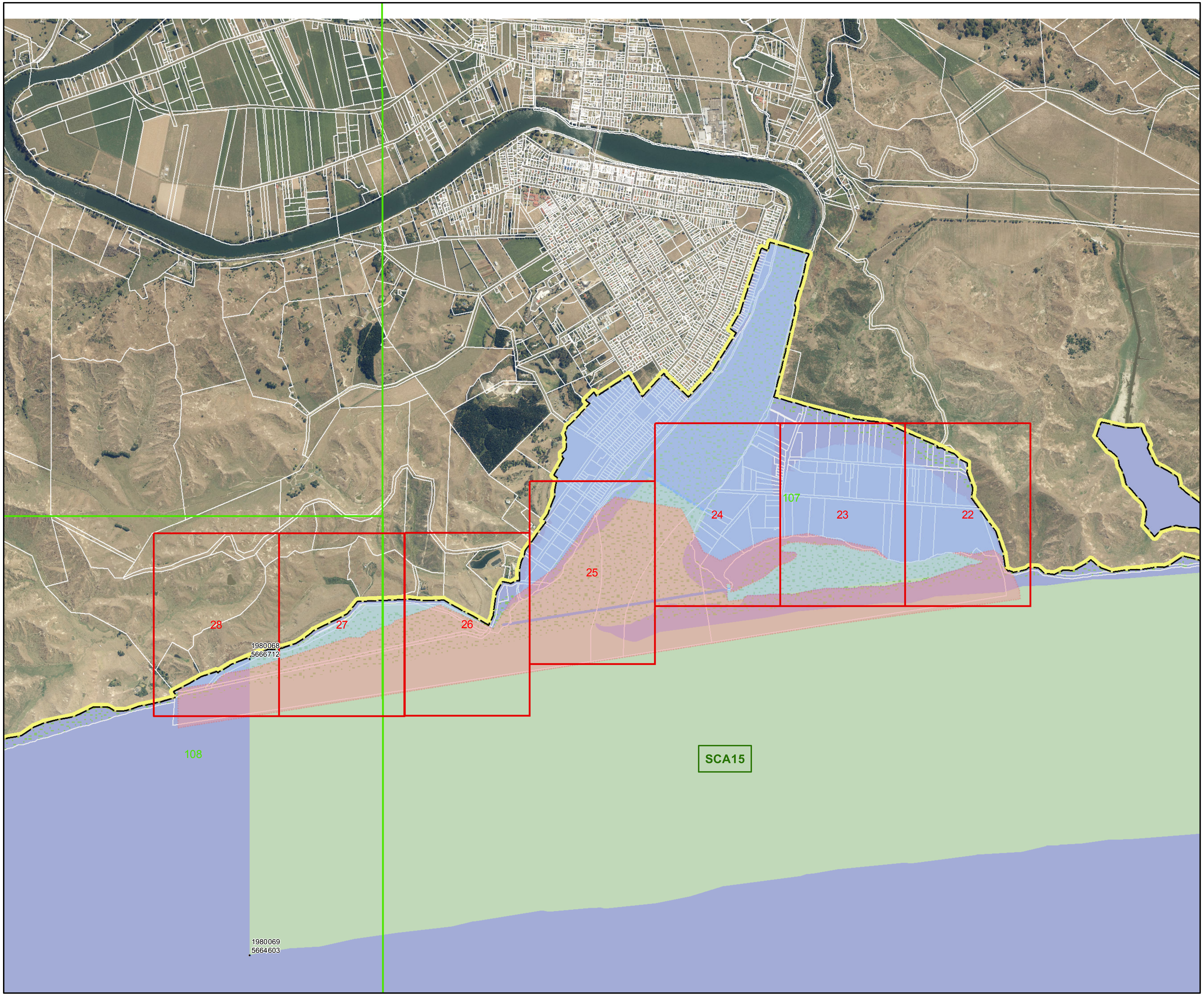
11APPENDICES

Appendix A Figures

APPENDIX A

Figures

Figure 1: Wairoa Coastal Environment



Legend

- 1:5000 Map frame
- 1:50000 Map frame
- Coordinate Labels (NZTM)
- Coastal Environment Inland Boundary
- Coastal Environment
- Coastal Hazard Zone 1
- Coastal Hazard Zone 3
- Properties
- Rivermouth CMA boundary
- Rivermouth
- Vegetation Clearance Management Area
- Significant Conservation Area
- Coastal Margin (Indicative only)
- Coastal Environment (Indicative only)
- HawkesBay_RegionalBoundary

Wairoa RCEP

NORTH

1:25,000

HAWKE'S BAY REGIONAL COUNCIL

DATA FROM: Information obtained from the Hawke's Bay Regional Council's Geographic Information Systems Database.

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