Preliminary Feasibility Assessments

Of Land Passage Options

(LEI, 2017:A5D1)

Prepared for

Wairoa District Council

Prepared by

Lowe Environmental Impact

October 2017

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Wairoa District Council

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TABLE OF CONTENTS

1 EXECUTIVE SUMMARY

1.1 Background

The Wairoa wastewater treatment system (WWTS) requires a replacement discharge consent to be lodged with the Hawke's Bay Regional Council at the end of 2018.

Based on hapu and community engagement, and direction provided by a range of regulatory policies, some form of land discharge is preferred.

The use of a land discharge system that provides for contact with Papatūānuku is a preference for tangata whenua; whereby the wastewater's discharge does not have a negative impact on the mauri of the surrounding waterways.

A range of land passage options are possible, but affordability is a critical element when considering their feasibility. The Wairoa Stakeholder Group has reviewed a wide variety of possible options and has sought further information on the use of a high rate land passage system (HRLP) prior to reaching the current river discharge location, and the use of a rapid infiltration (RI) system near the coast and to the west of Whakamahi Lagoon. These two options are considered along with a third, being a status quo option with some further treatment to reduce pathogen levels. These options are:

- 1a – Status Quo System With UV
- 1b – HRLP System and River Discharge
- 2- RI System and Coastal Discharge

This report provides a preliminary assessment of the feasibility and constraints of each system at two sites.

1.2 Option 1a - Status Quo System With UV Treatment

The current discharge structure will require further modifications if this is to be an option for future discharge. Adding a UV system would decrease pathogen loading of treated wastewater entering the Wairoa River, and this would achieve an improvement in water quality in the river and estuary, improve recreational acceptability, protect public health for recreation and seafood consumption, and slightly improve ecosystem health protection. However, its lack of land passage means that it does not address cultural values.

This current method of discharge will still be required if an HRLP system is installed (Option 1b), although the current location of this outfall pipe could be altered if hydraulic modelling of the discharge pipeline highlights this to be the best option. The current discharge pipeline and diffuser are within the coastal marine area as defined by the Regional Council Environment Plan (RCEP) and also (obviously) within the flood hazard risk zone. Its proximity to the ocean means that it is at risk of coastal hazards such as erosion, tsunami and climate change effects.

1.3 Option 1b - High Rate Land Passage (HRLP) and River Discharge

The process of the flow through a HRLP system aims to revitalise the mauri of the wai. This concept and the proposed structure is based on the inclusion of specific aspects of tikanga as identified in a report specifically prepared to identify Wairoa specific tangata whenua values. It builds on concepts used elsewhere around New Zealand that have served to incorporate contact with Papatūānuku, but provides a Wairoa specific interpretation of land passage.

Its location could be adjacent to the existing wastewater treatment ponds and utilise the existing discharge to the river. This HRLP design however, could have more than one purpose. Not only will it be used to revitalise the mauri of the wai that cascades through its passages, but this design could also be used as a demonstration model to show the community what could be achieved on a grander scale with regards to improvements to the wider Wairoa Catchment. It is proposed that a concept could be employed whereby:

> *The HRLP will mimic the water cycle and demonstrate what happens in the larger Wairoa River catchment and utilise intrinsic features specific to land and waterways in the catchment to aid in the return of the mauri to the water passing through.*

This design could mirror the current catchment, including specific geological and spiritual features. However, it should be noted that as water passes down through the streams and tributaries of the Wairoa River the mauri is currently being diminished by various contaminants and land practices. This the reverse of what is intended with a HRLP, whereby the water is cleansed as it passes downstream. Consequently, it could be considered that while still contributing wastewater to the Wairoa River, the HRLP is doing so in a way that demonstrates and symbolises that mauri and ecosystem health could be restored in the Wairoa River.

1.4 Option 2 - Rapid Infiltration (RI) and Coastal Discharge

The proposed site is wedged between the foreshore and Whakamahi Lagoon. Although RI allows treated water to pass through papatūānuku, the high rate at which the water will be applied to land will mean it very quickly reaches groundwater, from where it will most likely flow directly into Hawke Bay. There is the possibility that a portion may contribute back to the Whakamahi Lagoon.

Other considerations, such as planning and the various regulatory authorisations for a RI site on the foreshore reserve, need to be addressed. Additionally, the stability of the dune with high application rates will need to be assessed before this option becomes viable.

1.5 Option Evaluation

Options have been assessed in relation to the four pillars (i.e. Cultural, Environmental, Financial and Social/Recreational) and other considerations that include planning, technical and consideration of the wider catchment. These are summarised in Table 1.1. No one system fits favourably with all considerations. Overall, the HRLP + River Discharge generally has a moderate acceptability of the values and other considerations, with few disadvantages. The RI system will have a large focus on planning and financial constraints, but other considerations (especially no river discharge) are either favourable or moderately favourable. The Status quo + UV is least favoured due to having no type of land passage so fails to address cultural values.

Table 1.1: Summary of option evaluation

Consideration	Option 1a: Status Quo + UV	Option 1b: HRLP + River Discharge	Option 2: RI
Discharge Environment	River	Land passage then River	Sand dunes then sea
Technical -Design Practicality	Easy	Moderate	Moderate to hard
Social/Recreational – public acceptance	Minimal	Some	Some
Environmental – impact on river	Moderate	Low	None
Environmental – river mitigation needed	Highly recommended	Moderately recommended	Not required
Cultural – acceptability	Low	Moderate/high	Moderate/high
Legal/Planning – Planning Viability	Moderate	Easier	Hard
Financial – Annual increase to rates ($/connection)	Low $2.5 M – $3.3 M $98.30 – $130.53	Moderate $2.7 M – $ 5.6 M $106.31 – $222.63	High $ 3.9 M - $6.8 M $156.16 – $273.88

1.6 Recommendations

Further investigations will need to be conducted if either the RI or HRLP system are to be considered further. Particularly for the RI system an assessment of the stability and erosion risk of the chosen site is required to accommodate infiltration rates and associated earthworks for the proposed design. Additionally, further consultation with hapu and other affected parties such as DOC will need to be considered.

If the HRLP is considered to be an opportunity to further treat the discharge, then the structure could be developed in a way that allows the Wairoa River catchment to be simulated/modelled and used to demonstrate to the community the characteristics and features of the catchment; as well as opportunities to improve water quality. Should this concept be considered further, then engagement with the community is recommended, particularly for features to be identified by the communities living in that area of the catchment. Those communities could then ultimately be responsible for constructing their feature.

2 INTRODUCTION

2.1 Background

Wairoa District Council (WDC) operate the Wairoa wastewater treatment plant (WWTP) near Rangihoua (Pilot Hill) south of the urban area and west of the Wairoa River estuary. It discharges the treated wastewater through a submerged pipe into the Wairoa River estuary on falling tides between 6 pm and 6 am.

The current discharge consent issued by Hawke's Bay Regional Council (HBRC) expires on 31 May 2019. To meet statutory deadlines an application for new consent must be lodged with HBRC before 19 December 2018. Depending on the chosen option, there may also be the need to apply for land use consents from the regulatory arm of WDC for triggering District Plan consenting rules, and for concessions from the Department of Conservation (DoC) for infrastructure within the wildlife reserves which occupy most of the Wairoa River estuary area.

Prior to lodging any resource consent applications, the preferred option needs to be identified, investigated, supported by WDC, and a detailed assessment of effects prepared. This takes time and means that a decision on a preferred option is required as soon as practically possible.

The Wairoa Wastewater Stakeholder group was formed to consider and guide council staff on potential options. Amongst a range of options considered, the group has requested council staff to investigate high rate land passage (HRLP) and rapid infiltration (RI), ideally with no subsequent discharge to the river or ocean, in further detail.

2.2 Purpose

The purpose of this report is to conduct a preliminary assessment of a concept for a favoured potential design and location for both a HRLP and RI. This design should consider tangata whenua values as well as a wide range of other factors that have been identified by the Stakeholder group, including costs.

2.3 Scope

This report provides a high-level assessment of feasibility and constraints for both a both a HRLP and RI system. Design concept is for indicative purposes only, and considers:

- Discharge option selection process;
- Design parameter constraints;
- Cultural considerations (appropriate site and design);
- Site descriptions for HRLP and RI – land parcel, soil, geology, slope;
- Design options;
- Option evaluation against relevant criteria (technical feasibility, social and recreational values, environmental values, cultural values, legal and planning requirements, financial implications); and
- Potential costs.

3 DISCHARGE OPTION SELECTION PROCESS

3.1 General

There is a need to identify and develop options for a long term sustainable wastewater treatment and discharge system for the Wairoa community. The preferred option will be selected by elected members of WDC. However, they will seek guidance from the Stakeholder Group and community, which will in turn be informed by community representatives and WDC's advisors. The selection of a suitable option needs to consider what impact it may have on the community and the wider Wairoa Catchment. The options that are discussed in this report are based on the Wairoa Wastewater Stakeholder Group forming conclusions on selected values.

Guidance and suitability of a system will require consideration of a number of factors, including the performance of a system, its environmental effects, social and cultural acceptability and the ability of the community to afford such a scheme. The recommendation of a preferred scheme can be informed by the preference of the community, as they will have to live and breathe in the shadow of the plant and ultimately pay for it. WDC staff have chosen to actively involve the community in developing a preferred option; with their preference contributing to the recommended option presented to WDC councillors.

Further consideration, including catchment considerations, and background information that has assisted with reaching this point is provided in Appendix A.

3.2 Stakeholder Group

The Wairoa Wastewater Stakeholder group was formed in April 2017 to assist council to decide on a Best Practicable Option (BPO) for the future of Wairoa's wastewater discharge. As part of this journey the group considered options relating to the wider catchment and the treatment and discharge of Wairoa's wastewater. A key consideration was balancing wastewater discharge preferences and community affordability. The Stakeholder Group's overall preference was to cease the discharge to the Wairoa River and instead discharge to land. The cultural preference was to discharge through a land passage system of some form so that cultural values and tikanga could be incorporated. This preference of ceasing river discharges and land passage was also reflected in discussions with the larger community and not just Tangata Whenua.

The Stakeholder Group was presented with 22 potential discharge options that were suitable for Wairoa. These were presented to the Stakeholder Group as an appendix in a memo outlining wastewater options and a holistic river approach (Rationale, 2017). Options ranged from discharging 100 % water to 100 % land discharge. Total high-level costs varied from $1.8 M to $51 M, which represented an average rate increase of $74 to $2,048 per year per wastewater connection (LEI, 2017:A7D1).

These options included a final discharge as either: status quo, river, ocean, land or a combination of water and land discharge. Within these final discharge options, further treatment considerations were included such as UV and filtration. Reticulation options included either maintaining the current flow or reducing to 50% of current flow, and storage options ranged from minimal (2-3 days) up to 120 days storage for irrigation options.

Indicating the representative household rate increase when discussing the options assisted the Stakeholder Group to identify options that were financially affordable. By consensus within the group, it was considered that options to be considered further should not result in rate increases for each connection exceeding $400 per year. Additionally, consensus was that all future discharges should have some form of land passage to assist in meeting cultural, environmental and social values.

In meeting these criteria, from the suite of 22 options identified, there were two affordable options that provided land passage, being either a high rate land passage or rapid infiltration option.

3.3 Land Passage Options

The Stakeholder Group agreed that further work should be undertaken to assess the two land passage discharge options, being:

1. High rate land passage (HRLP) followed by discharge to the river; and
2. Rapid infiltration (RI) into the coastal dunes and by sub-surface discharge to the ocean.

These options have been considered as they are within the recommended costs that are likely to be affordable to the rate payers of Wairoa. Not only were the financial considerations important in this decision to review these option in more detail, but identifying a system whereby wastewater could pass over or through papatūānuku was necessary.

This report identifies a site that is suitable for developing each alternative discharge system based on the outcomes of previous reports and investigations. The key criteria for designing the discharge systems are also described in Section 8 and 9.

This report also considers the feasibility and constraints of potential design options for both land passage concepts (Section 4) at the potential sites which are to be refined should a conceptual design be needed in future stages of this project. It also compares these land passage concepts against a modified status quo option of installing filtration and UV treatment at the outlet of the WWTP prior to discharge of the treated wastewater to the existing (or modified) Wairoa River estuary outfall. The acceptability of the suggested discharge systems at these sites is assessed against technical feasibility, social and recreational values, environmental values, cultural values, legal and planning requirements, and financial implications.

4 DESIGN PARAMETER CONSTRAINTS

4.1 Existing Treatment System

Details of the existing treatment system are provided in the WWTP System Data and Compliance Summary report (LEI, 2017:A2I1). In summary, the existing WWTP design consists of a screen to remove debris, an aerated lagoon, and a maturation pond. The ponds have a combined total volume of about 23,000 m^3 (mainly in the maturation pond which is about 5 times the size of the aerated lagoon). The aerated lagoon is about 3.4 m deep, while the maturation pond is about 2.0 m deep. Two aerators are operated on the aerated lagoon, while the maturation pond is not mechanically aerated.

Currently there is no UV treatment or filtration of the treated wastewater as it leaves the outlet of the maturation pond. Storage of up to 5,400 m^3 (1-2 wet days of flow) is available at the WWTP, mainly by surcharging the maturation pond by up to 500 mm above its normal operating level.

4.2 Treated Wastewater Flows and Quality

Wastewater flows and quality are presented in previous reporting (LEI, 2017:A2I1). In summary, daily wastewater flow averaged about 2,700 m^3/d during 2009-14, with average summer flow of about 2,200 m^3/d and winter average flow of about 4,000 m^3/d. Peak storm flows are 5,000-6,000 m^3/d, with the highest 5 % of flows exceeding 6,300 m^3/d. The maximum recorded flow during 2009-14 was about 8,000 m^3/d.

Table 4.1 summarises the quality of the treated wastewater that is discharged from the WWTP, based on monthly grab sample monitoring data for 2008-16.

Table 4.1: Treated Wastewater Quality for Wairoa WWTP

Parameter	Range	Mean	Median
pH	6.4 – 9.3	7.6	7.6
COD (g/m^3)	34 – 620	158	126
CBOD (g/m^3)	6 – 190	31	23
TSS (g/m^3)	7 – 290	64	52
E. coli (cfu/100 ml)	8 – 470,000	5,250	5,200

The median treated wastewater quality indicates that the WWTP is generally performing to an acceptable standard.

4.3 Discharge Controls

If discharging to river or estuary, WDC MAY need to maintain the current regime of discharging only during out-going tides between 6 pm and 6 am. This regime could remain an option that is used for coastal dune or direct ocean discharges too, but it is possible that the discharge could be allowed to occur continuously (day and night) if public health is unlikely to be affected by such a change to the discharge regime. A longer duration of discharge, perhaps with increased limits on the daily volume of discharge, will also assist with managing the design of the necessary infrastructure.

Restrictions on daily discharge volumes or times of day may require storage in addition to the existing 5,400 m^3 that is made available by way of WWTP level fluctuations.

The consented daily discharge volume limit is currently 5,400 m^3/d, but occasionally large storm events cause flows that exceed this limit. A peak daily wastewater flow rate of 8,000 m^3/d which equates to 90 L/s has previously been recorded. The flow increase is largely driven by stormwater inflows, not increases in population or wastewater production rates, so it is more dilute than typical community wastewater quality. During storm events the river is generally flowing faster with high loads of silt and other contaminants, and recreation or food gathering activities are very unlikely to be occurring, so discharges of treated wastewater during such storm events will not affect the river or ocean water quality and will not affect public health.

The discharge system needs to accommodate a peak daily wastewater flow rate of 8,000 m^3/d, as extreme storms may continue to generate similar flows and the WWTP system is unlikely to be able to store all of the excess flow. There may be scope to increase the consented flow limit for the future discharge consent and, if this is acceptable to HBRC, the discharge system designs need to be capable of coping with such flows. At all other times, an average flow of 2,700 m^3/d or 30 L/s needs to be used for the discharge design.

A range of land discharge options is available. Deficit irrigation controls the rate of wastewater irrigation to match the capacity of the soils and plants to retain it. Deficit irrigation is generally impossible during the wetter and cooler months of each year, as the soils are already wet. Non-deficit irrigation controls the degree to which the wastewater irrigation exceeds the soil water holding capacity and how much is allowed to drain into the underlying groundwater. Rapid infiltration deliberately applies wastewater at a high daily rate to force most or all of it to drain into the underlying groundwater after a short contact time with soils.

HRLP systems will generally involve flow across the land surface in addition to draining as much as possible through the soils into the groundwater below. HRLP systems will often have a residual wastewater flow from their outlets which then needs to be discharged to irrigation or a water body (fresh water or the ocean) as the final discharge stage.

5 TANGATA WHENUA CONSIDERATIONS

5.1 Wastewater and Maori Worldviews in Wairoa

The Tangata Whenua Worldviews for Wastewater Management in Wairoa report (How & LEI, 2017:A4I2) provides a detailed description of Wairoa hapū connections with the district and their values and tikanga in relation to waterways and human waste management. The key conclusions of that report are as follows:

- Water is a living entity – it has a mauri and is a mauri itself;
- Tikanga are cultural law, not cultural lore;
- Direct discharge of wastewater to any waterway, including the sea, is culturally offensive;
- Wastewater needs to be revitalised through mimicking natural processes;
- Hapū, usually via marae, are the Tangata Whenua entities to be consulted with;
- Karakia/Inoi are an essential part of any development;
- Wāhi-Tapu are the only category of significant sites that need to be actively avoided by development;
- In the first instance land-based discharge of wastewater is culturally appropriate; and
- In the second instance a purpose-built land-passage wastewater system is culturally appropriate.

The following sections provide further discussion of these key points from the Tangata Whenua Worldviews for Wastewater Management in Wairoa report insofar as they relate to the discharge systems assessed below.

5.2 Cultural Values and Tikanga

Traditionally Maori have always kept human wastes separate from fresh water bodies, food cultivation areas, and communal living areas. Pit latrines were traditionally dug outside of villages and operated on the basis of natural composting of the wastes while protecting surface water and food sources from contamination.

All aspects of a wastewater system need to avoid sites of cultural significance. These include tapu (sacred) areas such as urupa (cemeteries), ceremonial sites, fresh or hot water springs, and geographical features that have a special historical or spiritual connection. Areas of traditional or contemporary settlements and food gathering or bathing activities should also be avoided.

Ideally water should have strong mauri, reflecting the fact that all life forms rely on water for their existence and good health. The mauri of water is greatly diminished when wastes are allowed to flow into a fresh water body. A common Maori cultural belief is that the very poor mauri of wastewater can be revitalised by passing the wastewater through papatūānuku (earth) prior to the resulting water flow having any opportunity of reaching fresh water bodies or the ocean. The ability of the natural processes within soils and plants to biotransform (and allow the water to be transformed from tapu to noa) the wastewater components and to revitalise mauri of the residual water is related to the opportunity for the material to have contact with soils and plants. This process of land passage over and through papatūānuku creates the opportunity to revitalise the mauri of the water.

Assisting with the elements of land passage, there are a number of spiritual practices that can also assist with revitalising water's mauri. These include ceremonies with karakia or inoi to free the land for development prior to construction, and to sanctify the site for its new purpose once the works have been completed.

The appropriateness of systems and design to assist with biotransformation is specific to the tangata whenua. This means that representatives of local hapu need to be actively involved in selecting the discharge system and its location, designing its cultural elements, contributing to its construction, providing cultural guidance, and contributing to spiritual practices, including any necessary karakia/inoi.

5.3 Cultural Acceptability of Discharge Options

There is a continuum of discharge options between 100 % to land and 100 % to water which has a continuum of cultural acceptability between 100 % appropriate to 100 % unacceptable respectively. Some treatment methods (principally involving water assimilation into soils and plant uptake) increase the cultural acceptability of human wastewater discharge systems. Figure 5.1 below provides a rough guide to the cultural acceptability of the main types of discharge options.

No drainage	Drainage to groundwater		Overland flow	Direct discharge to water	
Deficit irrigation	Non-deficit irrigation	Rapid infiltration	High rate land passage	UV treatment without land passage	No land passage, no UV treatment
Culturally ideal	High to moderate cultural acceptance			Low cultural acceptance	Culturally unacceptable

Figure 5.1: Cultural Acceptability Indicator for Discharge Options

The degree to which wastewater is prevented from entering a water body and is instead retained within soils and plants is closely related to the cultural acceptability of the discharge. Achieving zero drainage into groundwater is only possible using a deficit irrigation regime, but this is the ideal outcome for avoiding cultural offence. RI has high to moderate cultural acceptance because the wastewater does not generally return to the land surface or visibly discharge into waterways, but its lack of plant contact and nutrient uptake is a drawback. HRLP, despite contact with land and plants, has moderate cultural acceptance because a residual overland flow still needs to discharge somewhere, and this is usually a fresh water body (stream, river, or lake) or the ocean.

The design of a land passage system should aim to ensure that there is drainage through the soils, ideally some splashing against locally sourced rocks (allowing mixing with air), gravels, and plants, mixing of flows within stream channels, and variety between steep rapids or small waterfalls through to deeper slow-moving pools. Straight channels should be avoided in favour of channels that emulate natural waterways with their variety of meanders and sharper bends. Wastewater should be constantly flowing within the system if possible.

6 SITE DESCRIPTIONS

6.1 Site Identification

The Land Treatment Opportunities report (LEI, 2017:A5I1) reviewed land within a 10 km radius of the WWTP for its likely suitability for land discharges of Wairoa's treated wastewater (Figure 6.1). It concluded that suitable land was limited by slope and drainage, and that the flat land adjacent to the Wairoa River, north of the Wairoa township and south of Frasertown were the most highly preferred areas. It also concluded that areas adjacent to the WWTP and along the coast margin may warrant consideration for high rate application systems, noting there may be coastal erosion and planning issues which also need consideration.

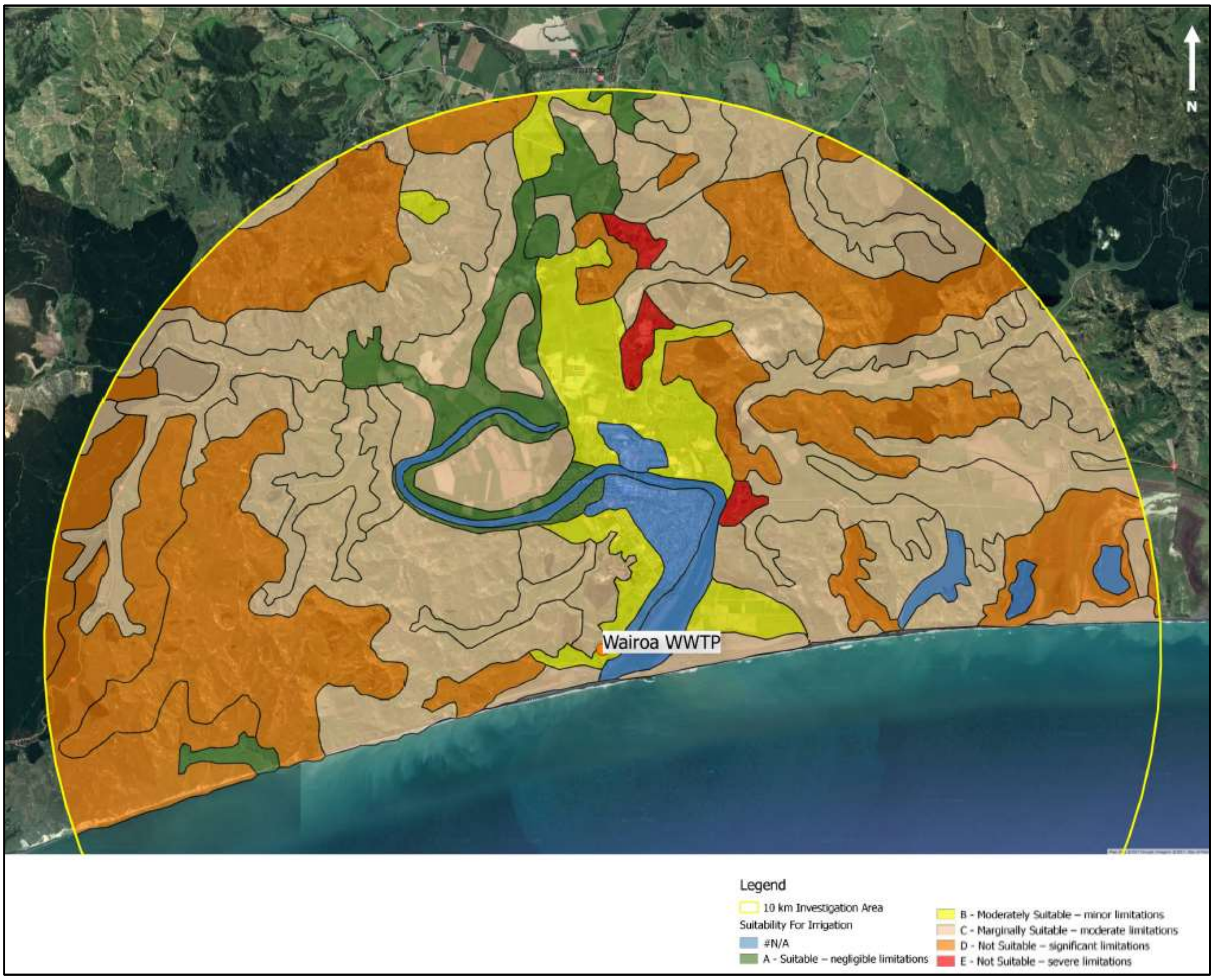

Figure 6.1 Land suitability for land application within a 10 km radius of the WWTP

Any HRLP site needs to be located somewhere in the vicinity of the WWTP and prior to a discharge to the Wairoa estuary via either the existing or modified outfall (described in more detail in Section 6.2 below). The obvious potential HRLP land areas are east and south of the WWTP. The key features are gentle slope, elevation above flood hazards, and adequate land area with suitably draining soils. The selected site also needs to avoid all known culturally significant sites.

Any site used for RI need rapid draining soils, which are uncommon in the Wairoa area. The most obvious sites are the coastal dune areas, provided that coastal hazards can be managed and the distance from the WWTP is not too great. The western side of the Wairoa River is the most practicable location, as it is closest to the WWTP and avoids having to install a pipeline across the river. However, a number of known culturally significant sites and the Whakamahi Wildlife Management Reserve need to be avoided or consideration given.

6.2 Wairoa River Estuary Discharge Site

Should the decision be made to continue with the current discharge system, or a HRLP system needs to discharge to the Wairoa River estuary, the current discharge site and pipe could be used. The end of the current pipe is situated at a depth of about 1.6 m below the mean low water spring tide level of the Wairoa River estuary, approximately 150 m from the nearest shoreline adjacent to Fitzroy Street. It is also located within the Whakamahi Wildlife Management Reserve. Figure 6.2 presents a map of its location.

Figure 6.2: Current Discharge Location in Wairoa Estuary

Treated wastewater discharges by gravity from the WWTP through a 300 mm HDPE pipe directly into the Wairoa River on a falling tide during the hours of 6pm to 6am, up to a consented daily limit of 5,400 m^3/d.

The Wairoa River's median flow rate is 31 m^3/s and flow rates typically vary between MALF of 5.8 m^3/s and mean annual flood flow of 1,600 m^3/s. When Wairoa River flow rates are less than about 200 m^3/s, the incoming tides bring seawater into the estuary, but at higher river flow rates the river flow prevents seawater entry into the estuary. The tidal range is generally about 1.2-1.4 m. The bar occasionally closes across the mouth of Wairoa River so that the estuary and lagoons are sealed off from Hawke Bay and this forces the river to percolate more slowly through the coastal dune to reach the sea, which raises the water levels in the estuary and prevents seawater entry. The bar is mechanically opened by HBRC contractors if the river does not naturally create a new opening through the bar. Further hydrological details for the Wairoa River and its estuary are presented in the Existing Environmental Data Summary (LEI, 2017:A3I2) report.

The current situation sees this pipe buried with up to 3 m of sediment. During March 2017 a diffuser T was installed (protruding vertically from the riverbed into the waterway) to relieve back pressure caused by blockages and to clear the end of the pipe. However, this diffuser was then removed a month later as back pressure issues were still occurring with the discharge end currently sitting out of the main channel. Further information is located in the WWTP Data and Compliance Report (LEI, 2017:A2I1). To prevent overflows occurring along Fitzroy Street, an overflow pipe has been installed that directly overflows into the Wairoa River during times when discharge flows are larger than what the discharge pipe can contain.

The current discharge structure will require further modifications if this is to be an option for future discharge. Opus Consultants have been engaged to undertake hydraulic modelling to understand what is required to prevent further issues with back pressure and siltation blockages.

The discharge pipeline and diffuser are within the coastal marine area as defined by the RCEP and also (obviously) within the flood hazard risk zone. Its proximity to the ocean means that it is at risk of coastal hazards such as erosion, tsunami and climate change effects.

A new location for the diffuser outlet will likely remain within the Whakamahi Wildlife Reserve area and coastal hazard zone, but would be positioned in a more favourable location for avoiding operational difficulties. Its diffuser outlet design and orientation may also be modified to improve its reliability.

6.3 HRLP Site

After consideration of land options in the area surrounding the existing treatment system, the location and geological features for land parcel 1.1.3 shown in Figure 6.1 below have been considered the most suitable for a HRLP for the Wairoa WWTP. It is located on the slope below the north-eastern end (and current outlet) of the WWTP above the low-lying flats and well back from most dwellings and the Wairoa River.

Figure 6.1: Aerial Photo of Proposed HRLP Site and Locality

The land parcel is legally described as Part Lot 1 DP 3350 and is currently used as a paddock of a deer farm. Its western boundary is the eastern side of the WWTP site and its northern boundary is a paper road which the current WWTP discharge pipe follows.

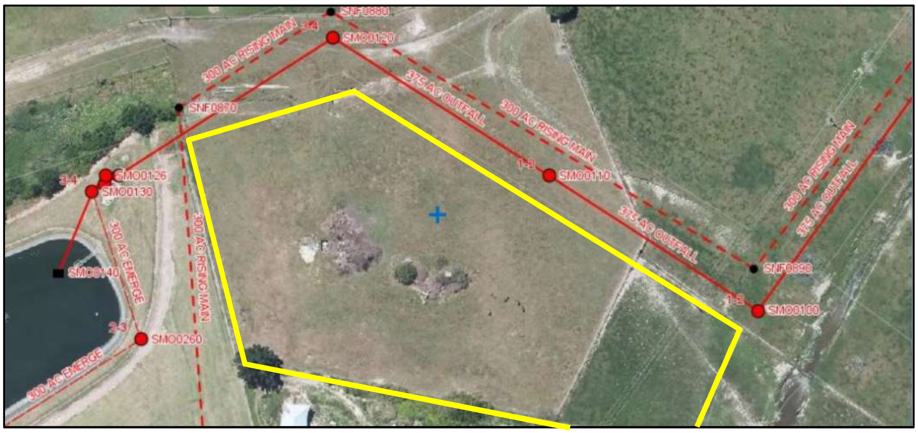

Figure 6.2: HRLP Parcel Boundaries and WWTP Discharge Pipe Route

Figure 6.3 provides the surveyed boundary lengths for the parcel of land which is a long pentagonal shape and does not match the fencing layout along its northern and eastern sides (the parcel is smaller than the fencing would suggest). The parcel is approximately 130 metres long and at the widest point 70 metres wide, and the whole area is about 0.75 hectares.

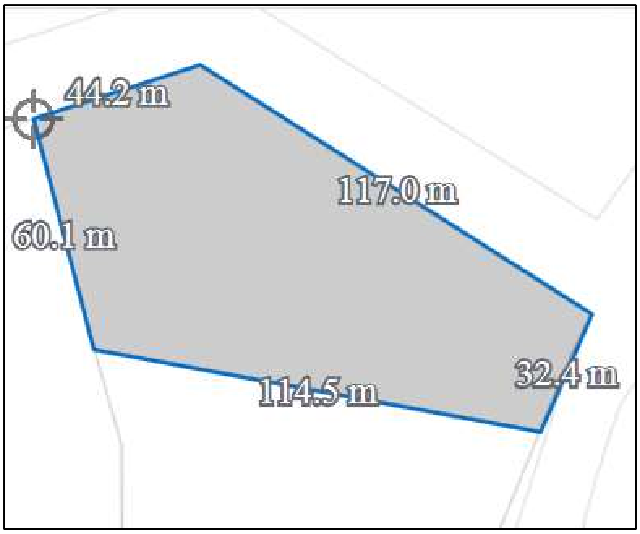

Figure 6.3: Dimensions of HRLP Land Parcel

The soil in the area is classified as "Gisborne sandy loam", and the depth to a slowly permeable horizon is between 1.2 and 1.49 m. The permeability in this area is rated as moderate and the drainage as imperfect (drainage class 3) (HBRC, 2017). The surrounding area is comprised of Awamate silt loam which may be slightly less permeable. The area is located on the eastern side of a small hill and includes the hill's slope. It is not affected by any flooding risk due to its elevation above the low-lying flats that occupy the Wairoa River valley (Goodier, 2006).

The area has a gentle to moderate falling slope towards the east. Figure 6.4 shows that the western and eastern areas have a gentler slope of 0 to 12.8 degrees and the central area has a steeper slope of 12.8 to 21.4 degrees. Steep slopes or low-lying flats are typical features of the surrounding locality, so this land parcel is one of the most suitable areas near the WWTP.

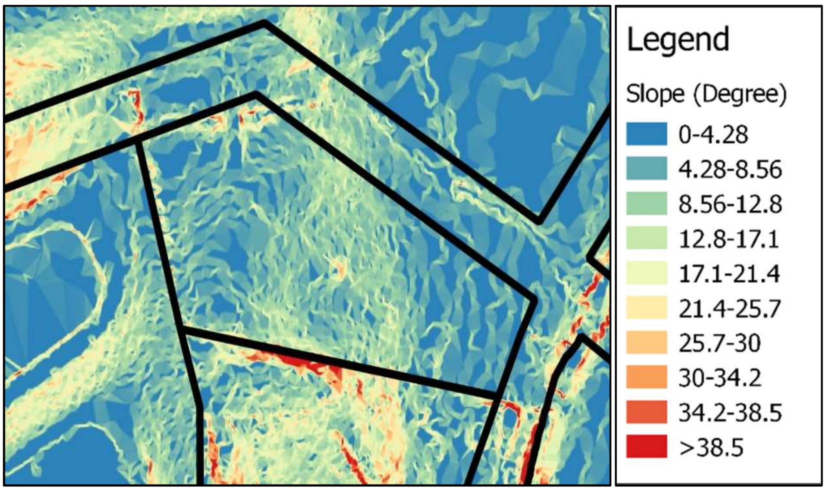

Figure 6.4: Slope

This site is outside of the Coastal Environment identified in the Wairoa District Plan (WDP) and the Hawke's Bay Regional Coastal Environment Plan (RCEP), so it avoids being subject to a large number of planning provisions. The Hawke's Bay Regional Resource Management Plan (RRMP) contains most of the relevant planning provisions controlling discharges and earthworks. It is privately owned land and also appears to be clear of archaeological and cultural significance.

6.4 RI Site

The proposed RI site is within coastal dunes at the western end of Whakamahi Lagoon. The site is approximately 2.3 km west of the WWTP, with approximate map coordinates of 39° 4' 6.23" S and 177° 23' 17.31" E at its western end. It occupies about 1 km of the coastal dune along Old Whakamahi Road towards the WWTP. Figure 6.5 presents an aerial photo of the locality with cadastral boundaries of the land parcels.

This site was chosen for its rapidly draining sandy gravel geology, its distance from the ecologically sensitive and culturally valued lagoons, and its relatively short distance from the existing treatment plant.

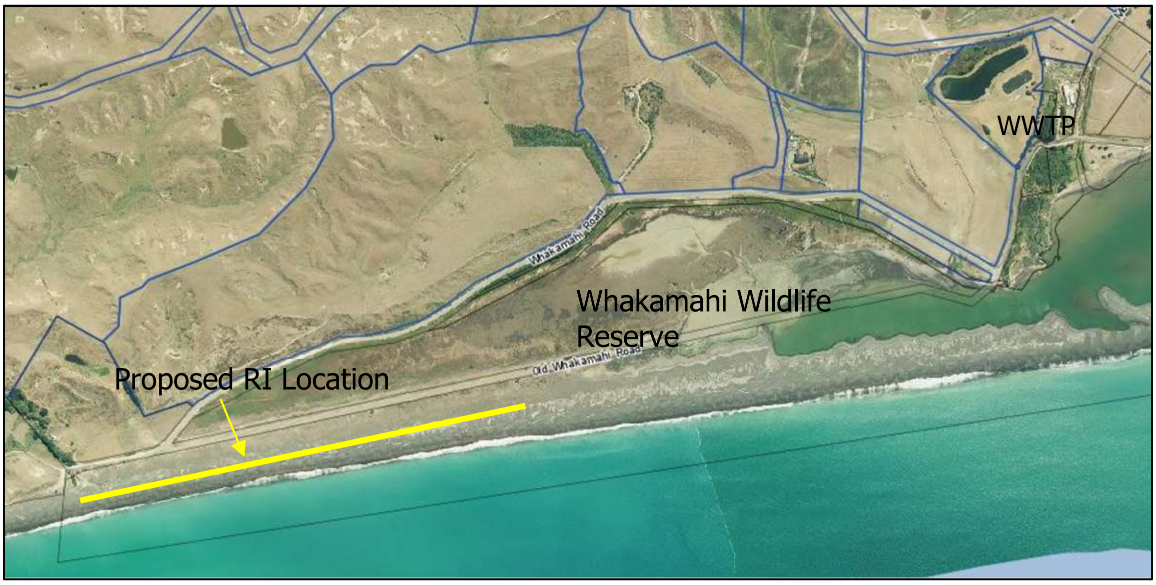

Figure 6.5: Aerial Photo of Proposed RI Site and Locality

Figures 6.6 – 6.8 identify the locality of the proposed RI site. These images give an indication as to the type of material that the RI site will occupy and additionally identify the locality in regard to Whakamahi Lagoon.

Figure 6.6: Proposed RI Site and Locality west of Whakamahi Lagoon. Note the gravelly sand costal dune material. (Source: P. Knerlich)

Figure 6.7: Proposed RI Site looking east along the Old Whakamahi Rd (red line), with Whakamahi Lagoon to the left of this. (Source: P. Knerlich)

Figure 6.8: Proposed RI Site looking west along the Old Whakamahi Rd (red line), with Whakamahi Lagoon to the right of this. (Source: P. Knerlich)

The Old Whakamahi Road site is a road reserve owned by WDC. A formed and maintained gravel road about 6-7 m wide occupies the centre of its 20 m width. The road reserve is about 2 km long between its junctions with Whakamahi Road, but its eastern-most 500 m is submerged within the permanent estuarine Whakamahi Lagoon.

During a site visit it was noted that an abrupt interface exists between the coastal gravelly sands and the underlying sedimentary rock layer which forms the adjacent coastal hill country. This geological interface appears likely to generally follow the inland edge of Whakamahi Lagoon and its wetlands near the coastal side of Whakamahi Road (Figure 6.9).

Figure 6.9: The interface between the sedimentary rock (left of red line) and the coastal gravel/sand (right of red line). (Source: H. Lowe)

The soil in the area is classified as land use capability V (LRIS, 2017), and the depth to a slowly permeable horizon is between 1.35 and 1.49 m. The permeability in this area is rated as rapid and the drainage as well drained (drainage class 5). An infiltration test found that the soil is gravelly sand with occasional cobbles and small boulders, as shown in Figure 6.10 below. Its drainage rate was 4.5 mm/s or 16,000 mm/h, which is very high (Knerlich, 2017:A5D2).

Figure 6.10: Soil Texture

The assumed groundwater flow direction is from the wetland and lagoon through the coastal dune and into Hawke Bay. It is possible, perhaps quite likely given the rapid drainage of the gravelly sand dune, that tidal fluctuations affect the groundwater slopes or levels and flow rates through the dune. Flood events (and water in the Whakamahi Lagoon) will also increase the groundwater slope and flow rate as it forces its way through the dune into the sea. Some care may need to be taken in the design and operation of the RI system to avoid or minimise the potential for wastewater discharges to cause mounding of groundwater beneath the dune and consequently forcing some drainage to flow inland and into the lagoon instead of the sea.

The RI site is on the inland lagoon side of the coastal dune crest and is stabilised by vegetative cover. Despite this, the entire dune and lagoon area are in a high coastal hazard zone as a result of the mobile dune, high energy ocean effects, and migratory Wairoa River mouth which is known to have migrated back and forth along about 2 km of the coastal dune's length. It is at risk of damage from severe storms and tsunami, and climate change could exacerbate its risks.

The Whakamahi Lagoon was originally fed by the stream just west of the RI site, but at some stage during the development of the area it was diverted directly to the sea and the road now bridges it. There have been some suggestions of reinstating the stream's flow back into the western end of the lagoon, and the relevant agencies may implement this in the future.

As shown on Figure 6.11 below, the land on both sides of Old Whakamahi Road is a wildlife management reserve. It is vested in DoC and managed jointly by DoC with HBRC, WDC, iwi/hapu, and local organisations. The reserve has high value as a wetland habitat, but its flora does not appear to include rare or threatened plant species. Birdlife does include some threatened species such as banded dotterel. Lizards, spiders, and insects are likely to inhabit this reserve. Fish are free to migrate into the lagoon via the Wairoa estuary.

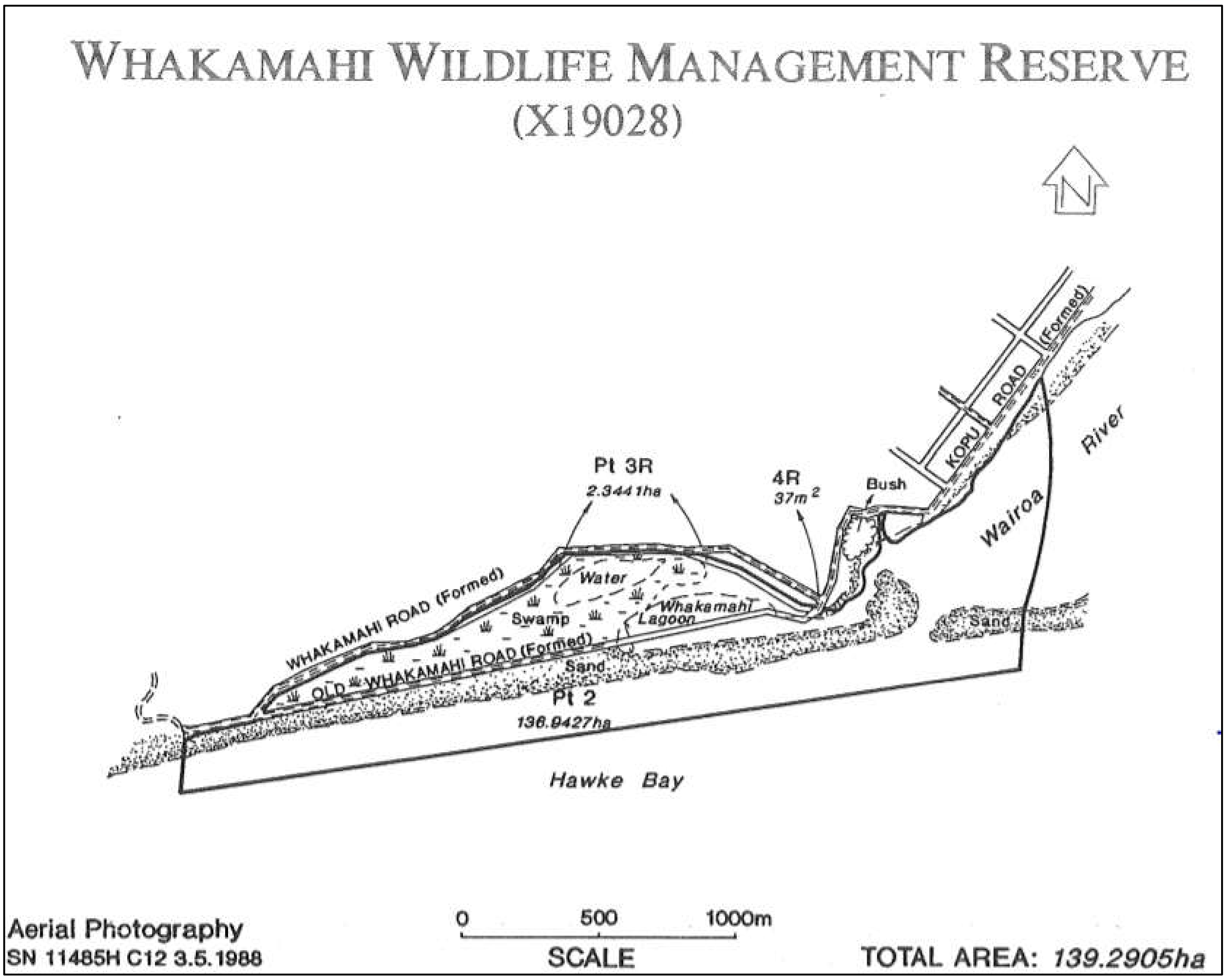

Figure 6.11: Whakamahi Wildlife Management Reserve (Source: CMS-ECC)

It must be noted that the identification of this location is based on its proximity to the WWTP while clear of ecologically and culturally sensitive areas, and potentially suitable geology for RI purposes. There has been no detailed planning or cultural assessment undertaken for this site at this stage. However, the planning provisions that apply to this site are clearly restrictive and will require detailed environmental and planning assessments. It may be difficult to obtain all of the required authorisations from all of the relevant regulatory authorities.

The proposed RI site is located within the coastal environment as defined by the RRMP, RCEP, NZCPS, and WDP. A large number of provisions in the RCEP, RRMP, WDP, NZCPS, and NPS-FM make infrastructure and discharges within the coastal environment more complex and difficult to obtain consents. The coastal hazard risks and potential implications for erosion and climate change need to be robustly considered and appropriate solutions need to be engineered into any RI design. Most of the RI site is within a Significant Conservation Area that is defined in the RCEP, and this has a specific set of policies, objectives, and rules to control the activities that can occur within this area without resource consents. Some specific activities are prohibited, but the RI system appears to avoid including any of those prohibited activities.

There are also Reserves Act and Conservation Act implications for this site, as it is surrounded by the Whakamahi Lagoon Wildlife Management Reserve. Any part of the RI located within this reserve will require DoC concessions and AEE's of the effects on this lagoon ecosystem. There may be difficulty obtaining DoC concessions, and gaining approval and input from iwi co-management. The discharge system must be consistent with WDC's reserve management plan for the area, including maintaining public access, and must not override the reserve's wildlife management purpose.

Customary marine titles and rights require direct consultation with the Maori claimants and, if they are granted these titles and rights, WDC must obtain written permission from the relevant groups before any resource consents or conservation concessions can be exercised.

7 POTENTIAL DESIGN OPTIONS

7.1 Preamble

The reason to consider alternatives discharge options is a result of the need for a new resource consent to be sought. The primary considerations for alternative discharge systems are impacts and consistency with cultural values and community aspirations of ceasing the direct discharge of treated wastewater into the Wairoa River estuary. Consensus from the community is that the status quo with no additional treatment is no longer acceptable. Therefore, the following three options have been identified:

- 1a – Status Quo System With UV
- 1b – HRLP System and River Discharge
- 2- RI System and Coastal Discharge

Work undertaken to date (including LEI, 2017:A7D1) suggests that the minimum potentially acceptable and lowest cost option is to install a further treatment system at the outlet of the WWTP to kill pathogens prior to discharging via the existing pipeline and diffuser in Wairoa estuary (Option 1a). This would protect public health through contact recreation and allow for recreation and seafood consumption. However, this level of treatment is not likely to be culturally acceptable if land passage options are not incorporated.

In order to provide contact with Papatūānuku (and to have certainty with public health effects), additional treatment prior to a discharge into a HRLP and the Wairoa River estuary is proposed (Option 1b). This level of treatment is more culturally acceptable than a discharge to water without any land passage. It allows for a variety of soil and plant interactions, with some plant uptake of nutrients and water, over a longer timeframe than RI systems.

An option which sees the cessation of a discharge into the Wairoa River is the use of a coastal dune site for RI. Installing RI into the coastal dunes allows for land passage and ensures that the drainage of residual wastewater enters the sea as a diffuse underwater plume. Further, a piped discharge from the land passage outlet into the ocean or river is avoided. This level of land passage is likely to be more culturally acceptable than a discharge that is piped into water, but the effectiveness of land treatment may be seen as less effective than HRLP.

Further detail on these three options is presented below.

7.2 Option 1a: Status Quo System With UV

7.2.1 Design Concept

Despite technical reporting suggesting there are no public health and adverse environmental effects with the current system, there is the need to deal with the public perception of wastewater pathogens reaching water that could be swam in and food gathered from. A new filtration and UV lamp disinfection process will be added to the WWTP outlet prior to the pipeline going down to Fitzroy Street and out into the estuary. There will be no change to the river outfall design and operation other than perhaps to reduce siltation problems or relocate the discharge pipe within the estuary. Figure 7.1 provides a concept of this system.

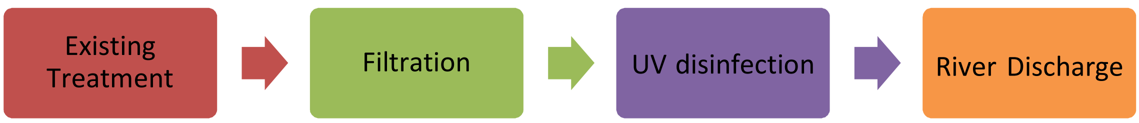

Figure 7.1: UV Treatment and Discharge Concept

This system will:

- Reduce the algae content of the wastewater and remove pathogens; and
- Discharge to the Wairoa River via the existing or modified structures.

This system will not incorporate any land passage components. Any changes to the estuary discharge structure or its location will generally be for operational and maintenance improvements reasons.

7.3 Option 1b: HRLP System and River Discharge

7.3.1 General HRLP Features

High rate land passage systems (HRLP) cover a range of concepts and designs, but essentially provide an opportunity for wastewater to pass rapidly over and/or through land on its way to reaching a receiving waterway, whether that be groundwater or surface water. This may mean that there is a lesser degree of treatment compared to low rate irrigation to land, but obviously provides an opportunity for land treatment than a direct discharge to water. Some options and their design concepts are presented in the Land Passage Summary Memo (LEI, 2017:A2D2).

The key design features of any HRLP system are flow controls for steep slopes (cascading steps or small dykes), vegetated edges and/or swale channels, moderate or higher draining soil substrate, gravel and boulder substrates, and often wetland type environments. They often aim to replicate natural systems, including ephemeral streams or wetland systems and to disperse wastewater as it flows down a slope into a waterway. Design features also incorporate aspects of contact with Papatūānuku, which are generally accepted as being capable of revitalising mauri of the wastewater, as explained in Section 5 above and the Tangata Whenua Worldviews Report (How & LEI, 2017:A4I2).

7.3.2 HRLP Design Concept for Wairoa

The key benefits and processes from an HRLP system include reducing wastewater derived contaminants through filtration and absorption through soil and plant uptake and aeration of wastewater resulting in a reduction of biochemical oxygen demand (BOD). In addition, the HRLP concept design for Wairoa will incorporate pathogen removal (as discussed in Option 1a). Furthermore, there is a need to acknowledge a Tangata Whenua aspiration of land passage to provide contact with Papatūānuku. These two requirements (pathogen removal and land passage) are essential elements of a HRLP system for Wairoa. Detailed below is a concept for what a HRLP system for Wairoa could look like.

After the wastewater has been treated in the current WWTP, and passed through the mechanical and biological processes within the ponds, it will pass through a new filtration and a UV lamp disinfection process before it enters the HRLP and then ultimately discharges into the river. Figure 7.2 provides a concept of this process.

Figure 7.2: HRLP Treatment and Discharge Concept

This system will:

- Improve oxygen levels and reduce BOD content through aeration before entering the Wairoa River.
- Reduce the algae content of the wastewater and remove pathogens;
- Allow the water to pass through and over a series of land passage elements; and
- Discharge to the Wairoa River.

The objective of the filtration and UV system is primarily to reduce pathogen levels. However, the HRLP objectives need to be defined and their scale determined. As a concept, it could be constructed for a secondary purpose of education to demonstrate to the (larger) community what happens within a water cycle and how land use (including wastewater discharges) impact on the mauri of the awa.

It is proposed that a concept is employed whereby:

> *The HRLP will mimic the water cycle and demonstrate what happens in the larger Wairoa River catchment and utilise intrinsic features specific to land and waterways in the catchment to aid in the return of the mauri to the water passing through.*

Key features will include providing for:

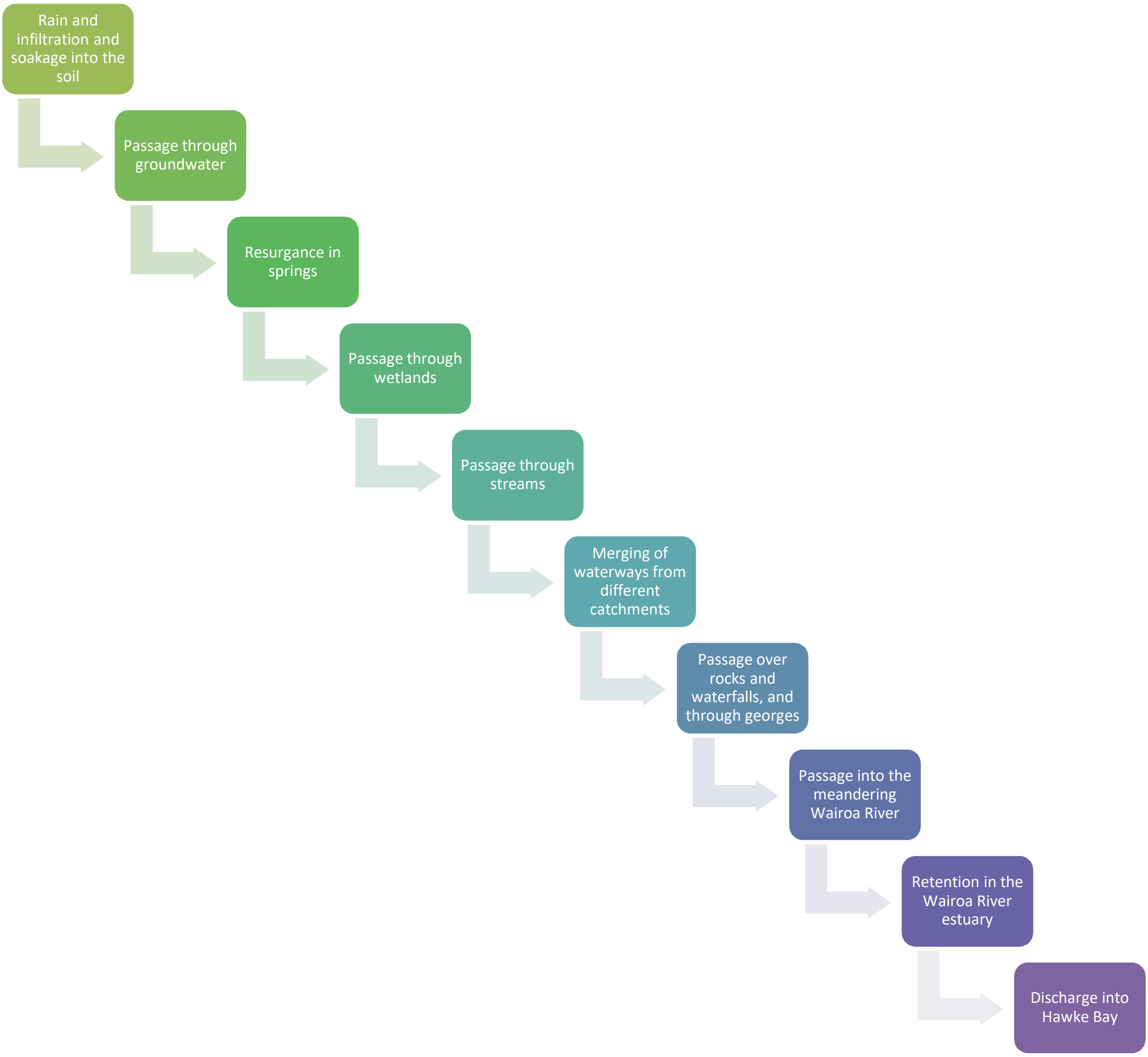

Figure 7.3: Key Features for the Wairoa HRLP

The HRLP design and operation can incorporate elements of the Maori worldview of water's intimate connection between Ranginui, Papatūānuku, and Tangaroa. Emulating the natural flow of water falls and over rocks emulates how natural water bodies maintain and revitalise the mauri of water and the connected environments.

Specifically, the concept of a possible HRLP would see sprinklers used to emulate tears (wairutu) from Ranginui to Papatūānuku, which is a direct intimate connection between these two spiritual entities. Some evaporation (whakaeto) from these sprinklers and other areas of the HRLP system again emulate the other intimate connection between these spiritual entities as wai returns to

Ranginui. Further, splashing and turbulence also allows contact and mixing of the wai with air (Ranginui).

Contact with rocks, soil, and plants allows transfer of mauri between these environments, including improvement of the mauri of plants due to their uptake of water and nutrients. Wetlands and planted riparian margins provide good opportunities for these interactions. Slow soakage through soils within streambeds and wetlands provide an intimate connection between the paruparu and Papatūānuku and opportunities for mauri revitalisation. Splashing and swirling around and over rocks and gravels is also important for the same reasons. A final phase of the passage through the HRLP would be the simulation of the meander of the Wairoa River, and in particular the heaving of the estuarine process associated with the rising and falling tide prior to the release to Tangaroa.

Representation of the awa (river), horanuku (landscape), geology and features of the wider catchment provide an opportunity for the passing wai to reconnect with the with the simulated catchment.

In drawing the attention to what is happening in that catchment, the HRLP system can emulate the wide variety of natural watercourse flow conditions, from gentle seeping springs, through wetlands and small streams, merging into larger steep rivers with rapids and waterfalls and deep slow pools, passing through gorges, and finally meandering across floodplains. Straight channels are rare in natural waterways, and the water is always flowing, even if it's not visible (such as lakes) or very slow, so it is important that the HRLP provides an opportunity for the recirculation of the water when it is not discharging from its outlet. Mixing of water is also important within a channel, and this occurs naturally with merging of streams, each bend of a waterway, and as braided river channels split and recombine. Strategic design of the channels, mid-stream boulders, and small islands in the HRLP will emulate these features.

In addition to providing a vegetation habitat, the HRLP system could become habitat for fish, eels (tuna), frogs and other reptiles, snails and insects, and birds.

Finally, it is noted that the process of the flow through a HRLP system is to revitalise the mauri of the wai. In reality, as water passes down through the streams and tributaries of the Wairoa River the mauri is currently being diminished by various contaminants. Consequently, it could be considered that while contributing wastewater to the Wairoa River, the HRLP is doing so in a way that demonstrates and symbolises that mauri and ecosystem health could be restored in the Wairoa River.

This HRLP design is therefore considered to have more than one purpose. Not only will it be used to restore the mauri of the wai that cascades through its passages, but this design could also be used as a demonstration model to show the community what could be achieved on a grander scale with regards to improvements to the wider catchment.

7.3.3 What HRLP Could Look Like

There are a number of ways the above concept could be developed and constructed. Ideally it would be done using local materials of significance with design and ideas representing important aspects and features of the larger Wairoa River catchment. There is also the opportunity that the community (and not just tangata whenua) could be involved in the project to develop and be responsible for various aspects of the design and construction. This could then serve as an education point with markers and notice boards along walkways highlighting the catchment features and features that assist with the enhancement and revitalisation of the river's mauri.

Figure 7.4 presents a design concept for the HRLP which is described in more detail below.

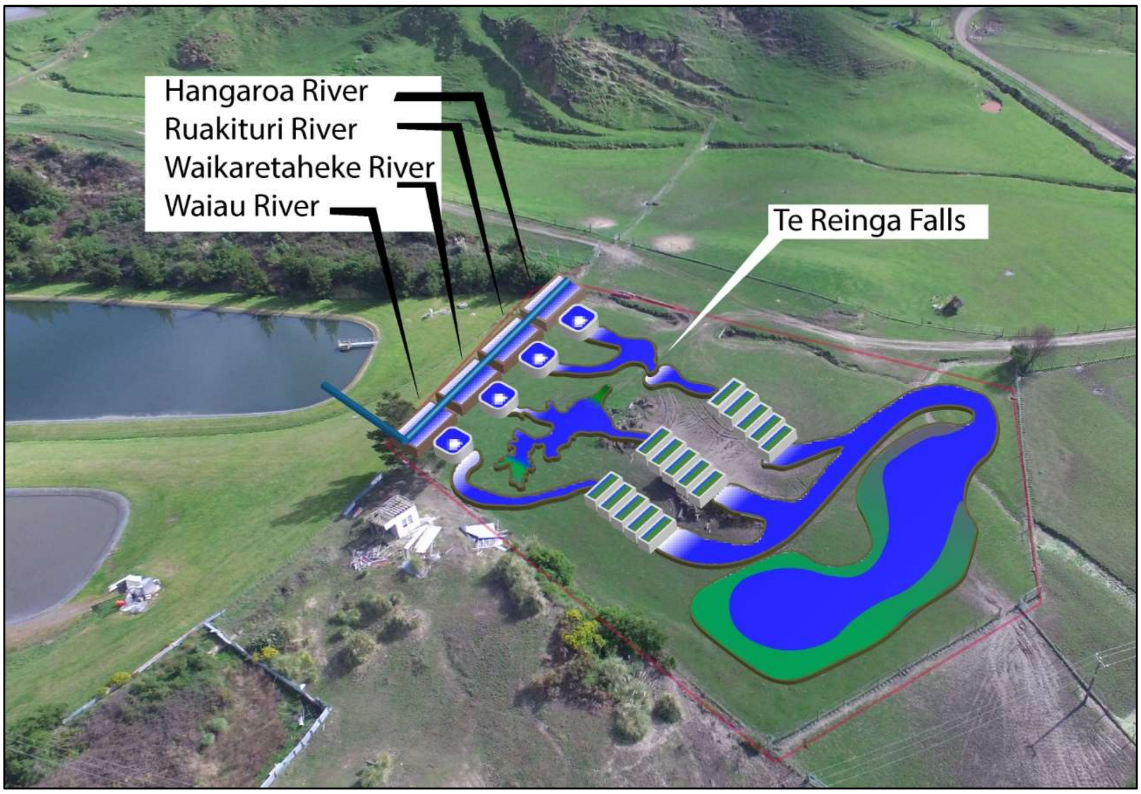

Figure 7.4: Design Concept Option for the HRLP

A diffuser pipe will spray the wastewater onto sand and gravel beds, replicating rain falling onto Papatūānuku. The proposed design is for the HRLP's waterways to be closely orientated to represent the catchments of the Wairoa River. Four sand or gravel beds represent the upper catchments of the four main rivers in the Wairoa catchment: Waiau, Waikaretaheke, Ruakituri and Hangaroa Rivers. The media used can be sourced from the upper catchment of the respective river system. Figure 7.5 presents an example of how each bed could be designed.

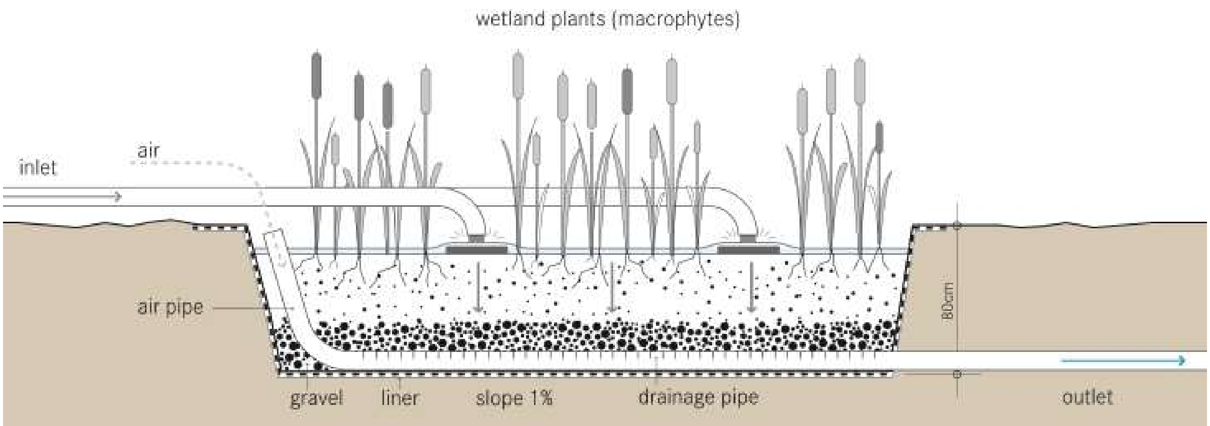

Figure 7.5: Sand or Gravel Bed Example for HRLP Inlet

The water flowing out of the sand or gravel beds will bubble up in a spring at each riverhead and flow through a swampy area planted with native plants common in that catchment. The swampy areas will flow into a channel for each of the four river catchments. Each channel will be designed to reflect the characteristics and features of the river it represents and planted with native plants which are typical for the catchment. For example:

- **Waiau River** has a fast flowing channel with a rocky bottom and could be shaped like an eel to symbolise the significance for the two native species: the longfin tuna and the blind eel.

- **Waikaretaheke River** could be designed closely to the shape of Lake Waikaramoana just below the spring. The channel could include a waterfall feature designed like the Taheke Waterfall.

- **Hangaroa / Ruakituri River** could include big boulders in the stream and the Te Reinga Falls where the two rivers meet.

Each river will need to have cascade steps, perhaps using gabion baskets, to traverse the steeper slopes of the HRLP site. Figure 7.6 presents an example of how this might look.

Figure 7.6: Gabion Baskets

The streams will then merge into a single channel with a meandering path that symbolises the lower reaches of the Wairoa River. The embankments will be planted with plants which are found along the banks of the Wairoa River. The wastewater will then flow into a lagoon designed to closely mirror the shape of the Whakamahi and Ngamotu Lagoons. It could also be designed as a potential habitat for eels and other native freshwater flora and fauna.

Water accumulating in the lower pond (represented by the lagoons) will discharge into the Wairoa estuary through the existing or modified discharge pipeline and diffuser. The fill and empty cycle could be seen to represent the rise and fall of the tide.

When the wastewater is not discharging to the estuary, a pump will be used to circulate the wastewater from the wetland back up to the HRLP diffuser inlet so that the wastewater within the HRLP is always flowing like a natural waterway. It also represents (if passed through the sprinklers) evaporation from the waterways with its return to the mountains and the source of the individual rivers.

7.3.4 System Sizing

The size of the HRLP system can be as big or as small as preferred. There is the possibility that the entire available land parcel could be used, and/or neighbouring parcels of land. This means the system could be several hundred meters long and as wide as needed. A realistic design might see a system 150 m long and 40 m wide.

7.4 Option 2: RI System and Coastal Discharge

7.4.1 General RI Features

RI systems aim to use well drained soils to rapidly drain wastewater into underlying groundwater bodies without surface ponding for more than a few hours following cessation of the inflow. The RI media usually requires containment, and this can be provided in trenches with aggregates wrapped in geotextiles, contained in gabion baskets or surrounding void crates. Figure 7.8 shows an option of a plastic water cell crate as an example.

As a consequence of their rapid drainage, the water has minimal contact times with soils and RI systems generally do not include plants except, wetland species or plants that can tolerate frequent ponding conditions. The groundwater receiving the wastewater ultimately continues to flow into surface water bodies or the ocean as it naturally did before the RI system was installed.

During the drainage process and travel with groundwater, the wastewater is in continuous contact with Papatūānuku which is generally accepted as being capable of revitalising mauri of the wastewater. However, it is probably less effective and less culturally valued than HRLP systems or irrigation which have longer wastewater contact times with, and uptake by, plants as it passes through.

A similar narrative could be developed for the RI system as has been described for the HRLP system above.

7.4.2 RI Design Concept for Wairoa

After the wastewater has been treated in the current WWTP it will pass through a new filtration and a UV lamp disinfection process before it enters the pipeline leading to the RI system. The intention is any drainage will immediately drain through the dune material along the foreshore and into the ocean. Figure 7.7 provides a concept of this process.

Figure 7.7: RI Treatment and Discharge Concept

This system will:

- Reduce the algae content of the wastewater and remove pathogens;
- Allow the water to pass through a land passage element; and
- Discharge by diffuse drainage into the adjacent Hawke Bay marine environment.

The objective of the filtration and UV system is primarily to reduce pathogen levels. The RI objectives however, need to be defined. It is proposed that a concept is employed whereby:

> *The RI will utilise intrinsic features specific to land along the coastline to aid in the revitalisation of the mauri to the water passing through.*

Key features will include providing for:

- Dispersion of the water along a broad length of coastal dune in order to avoid a narrow localised plume;
- Maximising opportunity for Papatūānuku contact by discharging near the crest of the dune and set back from the coastline;

- Allowing the selection of discharge field area to match the daily flow rates and to enable the use of a resting period rotation on a regular basis;
- Ensure structures and dunes retain their geotechnical stability; and
- Buried infrastructure to be managed to avoid damage to RI components and avoid visual effects on the natural landscape.

7.4.3 What RI Could Look Like

There are numerous design and layout options. Each would have a header or feed pipe distributing into laterals of varying length, and water cells might be incorporated if beneficial to the design and operation. A very basic concept drawing of a RI system is presented in Figures 7.8 and 7.9 and is described in more detail below.

Figure 7.8: Layout Option for the RI System

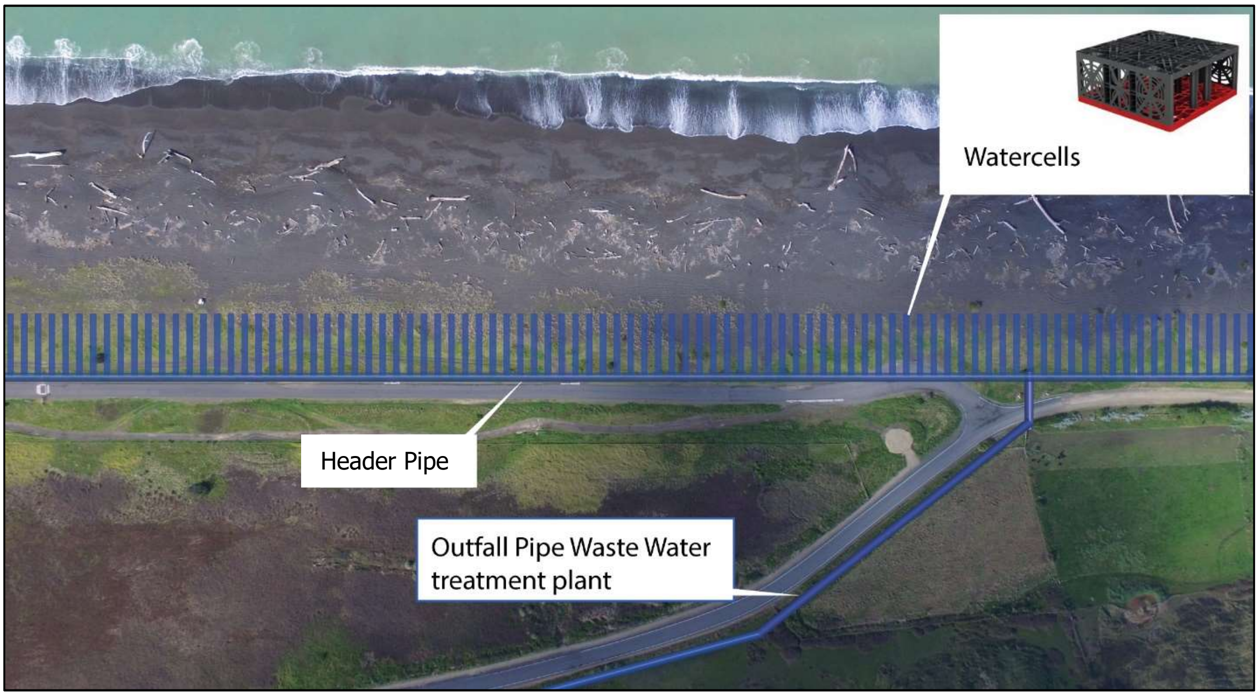

Figure 7.9: Design Concept Option for the RI System

The system would comprise of a main feeder pipeline that distributes the wastewater into a large number of laterals at least 10 m long. Each lateral would have a number of holes in it (say 1 m centres) and discharge into imported aggregate or disperse into 12 plastic water cell crates with the lateral inside it. The entire system will be buried within the dune to protect it from erosion and vehicle damage.

The discharge from the RI system will seep vertically down through the dunes into the underlying groundwater and then horizontally into the adjacent ocean. Depending on the location of the lateral (and the length of feeder pipe) there is the potential for some of the discharged water to travel east and north in the groundwater system and may enter the Whakamahi Lagoon.

Wastewater discharges to RIB will cause some mounding and may alter the flow direction, particularly during low tides and low river flow conditions, but a geotechnical assessment is required to determine the most likely consequences. It is also possible that an excessively high rate of application could destabilise the dune and make it more prone to coastal erosion, but this also needs to be assessed by geotechnical experts.

The number of laterals operating at any one time would be controlled and dependent on flows, with higher flow seeing a greater number being open. Ideally the use of the laterals would be cycled so as to allow some to be rested each day.

7.4.4 System Sizing

Land area requirements have been calculated for the RI system at three rates of water application: 200 mm/d, 500 mm/d, and 3,000 mm/d. An infiltration rate of about 16,000 mm/h has been measured at this site and therefore it could be concluded that the higher infiltration rate could easily be achieved. The test methodology and results are outlined in Appendix B. However, the stability of the dunes during high rates of discharge, and combined with storm surges, might impact on the stability of the foreshore dunes. Therefore, a conservative rate may want to be considered.

Table 7.1 outlines the land area requirements and length based on a 10 m wide RI field.

Table 7.1: Land Areas Required for Different Discharge Rates to an RI System

Daily Discharge Volume (m^3)	3,000 mm/d Application Rate		500 mm/d Application Rate		200 mm/d Application Rate	
	Land Area (Ha)	Length (m)	Land Area (Ha)	Length (m)	Land Area (Ha)	Length (m)
2,700	0.1	90	0.54	540	1.4	1,400
5,400	0.2	180	1.1	1,100	2.7	2,700
8,000	0.3	270	1.6	1,600	4.0	4,000

A 3,000 mm/d loading rate is very high and may result in dune stability issues, especially during storm events. A realistic infiltration rate may be 500 mm/d, and allowing for peak flow buffering at the treatment pond and period of short duration high volume discharge, a length of 500 to 1,000 m may be appropriate. This means that a header/feed pipe would be in the order of 500 to 1,000 m long. Assuming laterals were 10 m long and spaced at 5 m centres, 100 to 200 laterals would be required.

The available length of dune is limited by the areas of open water at the eastern end, and the width of road reserve restrict the potential land area able to be used for this RI system. It is unrealistic to occupy more than about 1.5 km of the dune, and it is preferable to minimise the width so that encroachment into the wildlife reserve is avoided or minimised. As a consequence of these restrictions, it is unlikely that a RI system based on an application rate of 200 mm/d is feasible in the land area that is available at this location.

7.5 Associated Costs

High level costs of the various system designs have been assessed. As there is detail still required to confirm designs, so there is likely to be a significant variability with the costs and they should be treated as indicative only.

Table 7.2: Indicative Option Costs

Option	Treatment		Discharge		Reticulation (WWTP to Discharge site)		Total Capital Cost		Design and Contingency (40%)		Consent & Investigation	Total Cost inc Contingency & Consent		Annual Increase to Rates ($/yr)		Weekly Increase to Rates ($/wk)	
	Lower Range	Upper Range	Lower Range	Upper Range	Lower Range	Upper Range	Lower Range	Upper Range	Lower Range	Upper Range		Lower Range	Upper Range	Lower Range	Upper Range	Lower Range	Upper Range
Status Quo +UV	$250,000	$400,000	$75,000	$ 500,000	$0	$0	$325,000	$900,000	$130,000	$360,000	$2,000,000	**$2,455,000**	**$3,260,000**	$98.30	$130.53	$1.89	$2.51
HRLP + River Discharge	$750,000	$2,400,000	$75,000	$500,000	$0	$0	$825,000	$2,900,000	$330,000	$1,160,000	$1,500,000	**$2,655,000**	**$5,560,000**	$106.31	$222.63	$2.04	$4.28
Rapid Infiltration	$0	$0	$450,000	$1,900,000	$300,000	$800,000	$1,000,000	$3,100,000	$400,000	$1,240,000	$2,500,000	**$3,900,000**	**$6,840,000**	$156.16	$273.88	$3.00	$5.27

7.5.1 Assumptions

- 1a – Status Quo System With UV – based on no changes made to reticulation or storage. Changes will be made to the current treatment method by adding a UV treatment system, additionally, the final discharge point requires modifications and improvements and these have been factored in.
- 1b – HRLP System and River Discharge - this is based on no change to reticulation or storage. An addition of the HRLP, including UV, filtration and modifications to the current final discharge point have been included.
- 2- RI System and Coastal Discharge - no changes have been made to the reticulation from town to the WWTP or storage. There is the addition UV and filtration. The addition of a RI system and reticulation of approx. 3.5 km to the discharge site have been included.

8 OPTION EVALUATION CRITERIA

8.1 Overview

Decisions need to be made on multiple variables (and values) in order to obtain a balanced overall assessment of preferred options. Some options have more implications for specific values, and some options entirely avoid triggering some concerns. Some options may have many benefits with only a small number of serious disadvantages. A very serious disadvantage can become the key determining factor in abandoning any further consideration of an option if the disadvantage cannot be overcome.

When comparing options, some values may be given more weighting than other values; often financial affordability is a more highly weighted value that can be the determining factor in selecting or abandoning a suitable option. An option may also be preferred because it most effectively addresses a highly weighted value; for example, an option that best addresses cultural values may be preferred over options that address these values to a lesser degree.

8.2 Technical Feasibility

Technical and physical features may determine how practicable an option is at any particular site. These include adequate land area, geotechnical suitability and stability, exposure or protection from natural hazards such as erosion, appropriate wastewater application rates, distance and terrain to be traversed for pipelines, and access (physical and legal). In order for any option to be suitable for further consideration, it must be realistically feasible at the selected location (or a location with similar key features) and using the same general design criteria.

8.3 Social and Recreational Values

The social aspect concerns how people view and react to wastewater discharges. It reflects the community's perception of how wastewater discharges should be managed and how the community reacts to and interacts with a given discharge. It also reflects the recreational and scenic values of the area around any discharge.

Key values identified revolve around water quality, and in particular the ability to swim, boat, or fish in the area as well as maintaining access to and enjoyment of the Wairoa estuary and its natural features. A key aspect is also providing for the health and wellbeing of future generations. This includes ensuring that the wastewater is treated to a standard that is socially acceptable for discharge and that the discharge protects public health, particularly for contact recreation and food gathering near the discharge site. An effective, reliable WWTP and connecting infrastructure are vital aspects of providing for and protecting the social stability of an urban community.

The selected location of the discharge also needs to be the most socially acceptable location. It is obvious that a remote location in an area that is rarely visited by people is vastly more socially acceptable than a discharge adjacent to the town centre or a popular recreation area.

It is noted that a number of the values are influenced by factors beyond the influence of the Wairoa wastewater discharge. For example, water quality in the lower Wairoa River is influenced not only by the Wairoa WWTP discharge, but also by the upstream water quality reaching the Wairoa estuary, and this is mainly driven by easily eroded sedimentary geology and a large rural catchment. Also, the management of the Wairoa estuary and its connections with the lagoons and ocean is a complex issue, of which the discharge of wastewater from Wairoa plays a part.

A road block to addressing social values is the ability to unite the community, with differing parts of the community seeing specific values, such as recreational needs, as being less important than other values.

8.4 Environmental Values

The community wants water quality that supports a healthy ecology in the lower Wairoa River, including its estuary and lagoons, and in the ocean nearby. This includes water quality that does not promote the growth of algae, and does not adversely impact on the fishery and wildlife values of the area. It is acknowledged that there are a number of urban contributors to poor water quality in addition to the Wairoa wastewater discharge, including stormwater and trade waste discharges. It is also acknowledged that the impact is not just on water quality but also the potential impact on the ecosystems of the entire estuary including the riverside reserves and the Whakamahi and Ngamotu Lagoon wildlife reserve areas.

A land-based discharge system needs to be sustainable and minimise adverse effects on the environment. The health and vitality of plants and soil biota need to be protected. Wastewater provides nutrients and water that help plants to grow, but application rates need to match the ability of the plants to withstand the increased soil moisture levels. The soil chemistry also needs to be protected from unsustainable changes, such as pH levels and nutrient accumulation or losses.

There needs to be a balance between minimising the amount of land required for wastewater discharges (which can limit the additional uses of the land) and minimising the amount of wastewater applied to an area of land and vegetation. In addition, the geotechnical stability of the land needs to be maintained. It would be disastrous if the wastewater discharge resulted in slippage or erosion of the land, as the land would no longer be suitable and the expensive infrastructure would be damaged or lost.

Discharges to land usually cannot avoid drainage of residual wastewater into the underlying groundwater or directly into surface water bodies. Care needs to be taken to ensure that any contamination of groundwater and subsequent contamination of surface water bodies is likely to be environmentally acceptable. Where groundwater is not used downstream for drinking water or stock water, the groundwater is usually allowed to be seen as less sensitive to contamination.

The discharge locations and infrastructure need to minimise exposure to natural hazards, avoid exacerbating the effects of natural hazards, and account for climate change effects on the scale and nature of natural hazards at the location. The design and operation of the discharge needs to carefully address these aspects.

8.5 Cultural Values

Cultural considerations largely (but not exclusively) revolve around tangata whenua aspirations, desires and customary practices. There has been a very clear steer from HBRC when granting the current consent and more recently from the Stakeholder Group that direct discharge to water without land passage is not acceptable. This view is also supported by non-tangata whenua. However, if land application is to be used there is a need to acknowledge sites of significance such as waahi tapu, tikanga Maori including tapu to noa and mauri revitalisation processes, and mahinga kai protection or enhancement. It is also important to consider how well each type of land passage system addresses cultural values, as generally slower land passage with full plant uptake is seen as culturally better than rapid drainage with minimal plant uptake.

8.6 Legal and Planning Requirements

RMA implications include assessments against the RCEP, RRMP, WDP, NZCPS, and NPS-FM. A large number of provisions make infrastructure and discharges within the coastal environment more complex and difficult to obtain consents.

There are reserves implications: the discharge system must not override the reserve's purpose and maintain public access. There may be difficulty obtaining DoC concessions, and gaining approval and input from iwi co-management. Both the RI site and the existing Wairoa estuary discharge structure and pipeline are located within the Whakamahi Lagoon Wildlife Management Reserve. Any changes to the existing discharge structure or implementation of the RI within this reserve will require DoC concessions and AEE's of the effects on this lagoon ecosystem.

Land access or easement/lease requirements need to be carefully arranged by WDC if private land is to be used.

Consultation is important for all of the planning processes. Customary marine titles and rights (RMA and Conservation Permissions) require direct consultation with the Maori claimants.

The duration of consents should seek to be the longest possible to minimise the repetition of the expensive exercise and to spread those costs over the longest timeframe possible. The criteria for acceptable scale of effects (less than minor) should be targeted in order to avoid public notification or at least minimise the reasons for public opposition and reasons for declining consents.

8.7 Financial Values

The ability to afford a wastewater scheme and any improvements is typically a bottom line that influences the choice of system and its location. It was acknowledged by the Stakeholder Group that what is desirable needs to be affordable, with many preferable schemes and options being simply unaffordable to the community. This requires consideration of both upfront capital costs as well as ongoing running and maintenance costs. The impact on urban ratepayers, including the term of any loan funding for the project is important to consider when assessing affordability.

It is also important to spend money in a focussed manner where it achieves the most benefits for the least cost if possible. In the case of Wairoa, a wider view is also important to consider: is it more efficient and preferable to spend several million dollars on the urban wastewater system just before the already polluted Wairoa River flows into the sea, or should a greater proportion of this be spent supporting farmers to reduce their impacts on the wider catchment?

The cost of gaining resource consents and all other authorisations can be significant. Costs generally increase substantially in proportion to the sensitivity of the receiving environment and the level of public opposition. The term of consent should aim to be as close as possible to the maximum 35-year term allowed by the RMA in order to spread the costs over the longest term possible and avoid frequent repetitions of this expensive exercise.

9 OPTION EVALUATION RESULTS

9.1 General

The benefits, disadvantages, and overall thoughts of each of the three Options are shown in Tables 9.1 and 9.2 below. Table 9.1 highlights the four pillars (environmental, social/recreational, cultural and financial) and how each pillar is affected by the three discharge options. Culturally, it is favourable for the discharge of treated wastewater to pass over land before it is finally discharged to water. Incorporating UV into the status quo, has no bearing on cultural considerations. Environmentally, all options provide some methods of further treatment before the discharge of treated wastewater, whether that is through the connection of land or increased pathogen treatment from UV. Financially, all methods will require a level of investment. This level will be determined on the basis of the type of system that is acceptable for both tangata whenua and the wider community. Socially, all options will carry the perception that discharging of wastewater to water is unacceptable. Although further treatment minimises the risk of public health concerns, this may not remove the stigma attached to wastewater discharge.

It must be noted that each system has its own issues that need to be highlighted. For example, the current outfall has issues relating to siltation blockages and backflows causing overflows and an upgrade of this system will be required for its continuing use. In relation to the HRLP system, the final discharge still requires the use of either the current discharge system or a new system/site whereby treated wastewater will be discharged to water. Upgrading of this system is required as outlined above. The RI system will require an area where high infiltration rates are acceptable. The site chosen for this is adjacent to the western end of Whakamahi Lagoon. This site although potentially suitable for RI, brings with it coastal hazards such as tsunami, storm surges and erosion risks. Further investigations will need to be conducted as to the structural stability of this site to withstand high application rates while avoiding destabilisation of the dune.

Table 9.1: Option Evaluations of the four pillars

Value		RI System	Status Quo + UV	HRLP System + River Discharge
Cultural	Benefits	Favourable, as all wastewater passes through Papatūānuku and avoids direct discharge into water. The site seems to avoid all culturally significant areas along the coastline. There would be no discharge to the Wairoa River.	There is no benefit for direct discharge to water.	Favourable. Treated wastewater passes over Papatūānuku using a variety of flow conditions before it discharges to water. Pathogen treatment improves acceptability of kaimoana for human consumption.
	Disadvantages	Its rapid and large drainage close to the sea may be less acceptable than HRLP or irrigation. There is also the potential for backflow into the Whakamahi Lagoon.	Direct discharge to water without land passage is culturally offensive.	Final discharge is via water to the Wairoa River which is not the preference. A 100 % to land discharge option would be more favourable if it avoided surface run-off or large scale drainage.
	Overall	The ability to pass wastewater through land before it enters water is acceptable; achieving an acceptable application rate is key.	Wastewater needs to pass over land before it enters water for discharge, and this option does not achieve this.	An acceptable method of treatment before discharge to water.
Environmental	Benefits	Occupies a very small land area and avoids the river. It probably avoids contaminating lagoon area and should not affect its ecosystems.	UV will protect estuary from pathogens. No more than minor impact on receiving environment from discharge, however in-river biota counts are low due to upstream silt sources. Discharging on out-going tides ensures good flushing and protects estuary except when river mouth is closed.	HRLP allows for some nutrient removal. Low pathogens and HRLP protect river biota and ensures a less than minor impact on receiving environment from discharge. Discharging on out-going tides ensures good flushing and protects estuary.
	Disadvantages	There is no beneficial nutrient recycling through plants due to limited vegetation here, buried RI system, rapid speed and large volumes of drainage. It will cause groundwater contamination adjacent to the shore. It is at risk of coastal hazards and may exacerbate those risks or suffer erosion.	When river mouth is closed, discharges still need to occur, minimising the flushing effect.	Further nutrient loading could occur if wildlife (i.e. birds) are to make this their habitat. Minimal flushing when river mouth is closed.
	Overall	Although land passage and no longer a river discharge, high rate application will cause groundwater contamination, yet this will filter directly to the sea and will have minimal effects.	The pathogen-free discharge will be better than the current discharge but will not have any other beneficial effects on the current state of the Wairoa River.	An HRLP allows for some nutrient removal and uptake, however this area could create further nutrient and pathogen loading if there is not an even balance of wildlife and plant/soil uptake.
Financial	Benefits	The cost of storage has been avoided. Only 2-3 km reticulation required to site – keeping reticulation costs manageable. Cost of consenting could be lower in recognition of the design addressing cultural and environmental values.	UV, filtration, and consenting will be the only costs because nothing else is being changed or upgraded.	The cost of major reticulation upgrades and storage have been avoided. Cost of consenting could be lower in recognition of the design addressing cultural and environmental values while avoiding the coastal environment and reserve areas.
	Disadvantages	Higher cost than an HRLP due to type of material required and earthworks needed for initial setup, and the 2-3 km of reticulation. Design costs may be high to ensure its suitability for coastal hazards. If planning provisions are not met, the cost of consenting and concessions may be considerable.	The consent for this option is likely to be more expensive than all others due to cultural and community opposition.	The costs of HRLP and UV treatment will be higher to cope with current flows. The cost of land purchase or lease may be a significant factor.

	Overall	Includes some major reticulation works, but RI system costs will be dependent on suitable design and public or regulatory acceptability.	Increased consenting costs are likely due further consulting time required for this to be agreed by tangata whenua and the public.	Consenting costs have considered the cultural needs.
Social/ Recreational	Benefits	This site could continue to be included as a reserve area as it would be visually similar to the adjacent Whakamahi Wildlife Reserve.	The time of discharge should not impact river users, but could impact on public perception. Pathogen treatment ensures there is no health risk for contact recreation or seafood consumption.	The time of discharge should not impact river users, but could impact on public perception. HRLP design could be visually appealing. Pathogen treatment ensures there is no health risk for contact recreation or seafood consumption.
	Disadvantages	Location may affect current users of the western end of Whakamahi Lagoon (i.e. fishing and kai gathering); create a negative perception	A negative public perception.	Size and position of HRLP could impact on current land owners/users.
	Overall	Could build on already existing conservation area but may have a negative perception.	Current system is not seen as totally acceptable by the public, and this option may not significantly improve that view.	Perception of a river discharge may not be favourable, however improved treatment methods minimises health risks.

Table 9.2 outlines considerations other than the four pillars. These considerations are important to understand for a final option and design. For example, planning requirements will need to be addressed and the legality of such systems need to be understood if these options are to go ahead, such as RMA considerations. Technically, these options range from the simple to the more complex and the final design of any of these systems will relate back to financial impacts. Finally, the consideration to the catchment and the impacts of a final discharge are indicated, only the RI system will fully remove the discharge of treated wastewater from the catchment.

Table 9.2: Other considerations for option evaluations

Other Considerations		RI System	Status Quo + UV	HRLP System + River Discharge
Legal/Planning	Benefits	It can fit within WDC's road reserve and seems to be able to meet most planning provisions.	No consents are needed for implementing any infrastructure changes.	Favourable, as it avoids the coastal environment and achieves the aims of the RRMP and RCEP.
	Disadvantages	Its location surrounded by wildlife reserve and within coastal hazard area make its planning assessments and consenting success more difficult. Coastal marine titles could add difficulties to gaining authorisations.	Re-consenting requires BPO, iwi acceptance, and public support which may all be difficult to demonstrate.	WDC will need to purchase the land if a lease is not acceptable to the landowner.
	Overall	More complex planning requirements due to its location in coastal hazard area and need to address coastal hazards. Reserve and coastal marine title implications may be difficult to navigate.	Re-consenting is likely to be difficult if it is not publicly supported as the BPO.	Favourable.
Technical	Benefits	Structural design elements used in this design create stability for the coastal dunes.	Basic discharge system, UV will minimise pathogens entering the Wairoa River.	Additional treatment addresses public health and cultural values while also improving the river environment.
	Disadvantages	Initial set up and earthworks required to install discharge system will disturb the natural environment in the short term.	Current system requires modifications due to blockages, and this is likely to continue to be a long-term problem.	Large modular HRLP and UV systems will be needed to handle the highly variable and large daily flows. May be unacceptable for consenting due to reliance on river receiving environment.
	Overall	Simple design that could assist with stability of the dunes but initial outlay will create some disturbance.	An upgrade of the current discharge system is necessary, and this is the minimum possible for discharge quality improvement.	Although costs of increased treatment are essential for this design, additional reticulation upgrades and a change to the discharge location are not required.
Catchment Considerations	Benefits	Removal of treated wastewater from the Wairoa Catchment, no longer discharging into the river.	Wastewater treated to a higher standard to minimise pathogens entering the Wairoa River.	Wastewater treated to a higher standard with UV and passes overland, increasing nutrient uptake by plants, minimising the amount of nutrients and pathogens entering the Wairoa River.
	Disadvantages	Discharge will still enter water (ocean) once passed through land.	Discharge point remains in the catchment and estuary.	Final discharge point remains in the catchment and estuary.
	Overall	Discharge removed from the catchment.	Future mitigation options to remove wastewater discharges from catchment may want to be considered and/or offset mitigation provided.	An improvement on status quo, yet future mitigation options to remove wastewater discharge from catchment may want to be considered and/or offset mitigation provided.

Table 9.3 summarises Table 9.1 and 9.2, highlighting the main points that need to be considered going forward. No one system fits favourably with all considerations listed in the Tables above. Overall, the HRLP + River Discharge generally has a moderate acceptability of the values and other considerations. The RI system will have a large focus on planning and financial constraints but other considerations are either favourable or moderately favourable. The Status quo + UV is least favoured due to having no type of land treatment.

Table 9.3: Option Summary

Consideration	Option 1a: Status Quo + UV	Option 1b: HRLP + River Discharge	Option 2: RI
Discharge Environment	River	Land passage then River	Sand dunes then sea
Technical -Design Practicality	Easy	Moderate	Moderate to hard
Social/Recreational – public acceptance	Minimal	Some	Some
Environmental – impact on river	Moderate	Low	None
Environmental – river mitigation needed	Highly recommended	Moderately recommended	Not required
Cultural – acceptability	Low	Moderate/high	Moderate/high
Legal/Planning – Planning Viability	Moderate	Easier	Hard
Financial – Annual increase to rates ($/connection)	Low $2.5 M – $3.3 M $98.30 – $130.53	Moderate $2.7 M – $ 5.6 M $106.31 – $222.63	High $ 3.9 M - $6.8 M $156.16 – $273.88

10 CONCLUSIONS

Guidance and suitability of a system will require consideration of a number of factors, including the performance of a system, its environmental effects, social and cultural acceptability and the ability of the community to afford such a scheme. The recommendation of a preferred scheme can be informed by the preference of the community, as they will have to live and breathe in the shadow of the plant and ultimately pay for it.

The addition of UV treatment and continuation of the discharge through the same pipe is unlikely to be acceptable. Both land passage systems have associated benefits and disadvantages. These can be concluded under the following headings:

Technical/Practicability:
HRLP - Although costs of increased treatment are essential for this design, additional reticulation upgrades and a change to the discharge location may not be required.

RI - Water cells are a simple design that could assist with stability of the dunes but initial outlay will create some disturbance.

Recreational/Social:
HRLP - Perception of a river discharge may not be favourable, however improved treatment methods minimises health risks. This system also provides the opportunity for locals to be part of a scheme that improves the quality of treated wastewater and the estuary.

RI – this system could be incorporated into the already existing conservation area but this may have a negative perception.

Environmental:
HRLP – this design will allow for some nutrient removal and uptake, however this area could create further nutrient loading if wildlife overpopulation occurs. The positive is that the system could be used as a model to demonstrate what is happening in the catchment.

RI - Although no longer a river discharge, high rate application will cause impact on as the rate of application and coarseness of the sands will have limited filtering. There is the possibility that there may be some residual discharge back into the Whakamahi Lagoon.

Cultural:
HRLP - An acceptable method of treatment before discharge to water, however there will still be a discharge to water after the HRLP.

RI - The ability to pass wastewater overland before it enters water is acceptable; achieving an acceptable application rate is key. However, there may be some concerns with the cultural significance of the area

Both of these systems allow wastewater to pass over and through Papatūānuku which is generally accepted as being capable of revitalising mauri of the wastewater. However, an RI system is probably less effective and less culturally valued than HRLP systems or irrigation which have longer water contact times with, and uptake by, plants as it passes through.

Legal and planning:
HRLP – Favourable option for ease of consenting as it avoids the coastal marine area, however land will need to be leased or purchased.

RI – More complex planning requirements than a HRLP due to its location in coastal hazard area and there is a need to address coastal hazards. Reserve and coastal marine title implications may be difficult to navigate.

Financial:
HRLP - Consenting costs have considered cultural needs, and avoids reticulation costs.

RI - Avoids the need for major reticulation works, but costs will be dependent on suitable design.

Ideally removing the discharge of treated wastewater from entering waterways that contribute to the wider catchment would be the ultimate goal. This would not only satisfy tangata whenua, but the community as a whole. However, financial and practical constraints limit this ability. The addition of a HRLP and UV system to the current discharge scheme would assist with removing more nutrients and pathogens than that of the current system, although this still results in discharging to the Wairoa River. The consideration of a RI system that is located adjacent to Whakamahi Lagoon would result in discharge of treated wastewater not entering the Wairoa Catchment, however, there are constraints associated with this location that will require further investigation if this option is to be selected.

11 RECOMMENDATIONS

Further investigations will be required for a preferred design option irrespective of this being a HRLP or RI. What has been presented in this report is at a high level and will need refining. Further community and hapu consultation will be required to guide council to a preferred option. Although consultation forms the basis of this option, further investigations to their practicality and feasibility are needed.

Recommendations for further work required to develop a preferred HRLP design will include confirmation and consultation with the land owner and neighbouring properties. The chosen site is on private land and will require approval from the affected parties and either a purchase or lease agreement to go ahead. A geotechnical investigation will need to be undertaken to determine the stability of the hill slope and its ability to have a continual flow of water cascading down it. This design will also require botanical expertise to plant out the HRLP site to reflect the native flora associated with the catchment that is then represented within this design. Further hapu guidance is recommended for the acceptability of this design and for all residents to take pride in.

This option provides a form of land passage where final discharge is via the current discharge outfall. Additionally, final discharge could be via a new outfall at a different location within the Wairoa River. Hydraulic modelling investigations are currently underway with the current discharge outfall system. This will determine what improvements are required to have this system functioning at full capacity. In the event it would be feasible to change the location and current discharge system, then this will require further time for investigations to occur. However, if the current system is adequate, any upgrades, again, will require time and investigations to determine the best discharge system.

Further investigations that will be required if the RI option was to proceed would include a geotechnical investigation of the area to establish stability of the underlying sediment. With high rates of application and a high infiltration rate, stability of the sand/gravel bed needs to be understood before such an option could proceed. Although the final RI design will be more at a technical level rather than a cultural level as expressed in the HRLP option, the RI option may not require the same level of hapu involvement for design purposes as the HRLP. However, hapu and other affected parties will need to have acceptance of the discharge method and its site, and this will be the determining factor for this system going ahead. This site lies adjacent and somewhat within the Whakamahi Lagoon Wildlife Reserve and will require acceptance from DOC. Effects on the environment of such a system will need to be addressed as part of this acceptance, especially groundwater contamination and flow direction. At such high rates of infiltration, wastewater will undoubtedly enter groundwater, if groundwater flow direction is directly out to Hawke Bay this will minimise any backflow issues and contamination within Whakamahi Lagoon and further inland.

12 REFERENCES

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13 APPENDICES

Appendix A Discharge Option Selection Process
Appendix B Soil Drainage Test Methodology and Results

APPENDIX A
Discharge Option Selection Process

Discharge Option Selection Process

General

HBRC's RRMP strongly encourages ceasing of direct discharges to rivers, and this is echoed in the resource consent decision and community feedback.

Whole Catchment Considerations

In selecting the HRLP or RI option, the wider catchment needed to be considered as to what affects the health and quality of the Wairoa River. The effects on the Wairoa River are formed from the surrounding land use, from the headwaters of the Wairoa Catchment in the Te Urewera Ranges, through to pastoral and horticultural land use and forestry and finally the township of Wairoa close to the mouth of the Wairoa River. All of these features have shaped the Wairoa River to what it is today. Overland runoff which carries nutrients, pathogens and sediment have affected the quality of this river. The Wairoa River is seen as one of the poorest quality rivers in the Hawke's Bay Region for turbidity and clarity, but this is mainly due to the erodible nature of the geology of the area and pastoral farming land use.

In referring to the microbiological water quality, the median water quality falls within the National Policy Statement for Freshwater Management (NPSFM) NOF "A" attribute state, which indicates that water quality is generally suitable for secondary contact (e.g. wading, boating); but at times, the microbiological water quality is unsuitable for primary contact (e.g. swimming). However, microbiological water quality was generally stable over time across the Wairoa catchment. Further information can be sourced from the Existing Environmental Data Summary Report (LEI, 2017:A3I2).

In addition to the wider catchment, the Wairoa WWTP contributes to the nutrient and pathogen load in the Wairoa River through point source discharges. The current reticulation system is affected by inflow and infiltration of stormwater and groundwater. When this system is overloaded, overflows can occur, discharging from the reticulation system and pump stations directly into the Wairoa River. However, this generally occurs during times of high river flow when it is unsafe for recreational and fishing use, therefore creating a dilution effect and minimising the risk to human contact.

Discharge of treated wastewater from the ponds is timed to that of a falling tide between the hours of 6pm and 6am when the river mouth is open. This is to avoid potential contact with recreational users. However, there are times when discharge may occur outside of these times, such as times when the storage system is overwhelmed with high storm flow rates. Further information relating to the WWTP are outlined in the WWTP Data and Compliance Report (LEI, 2017:A2I1).

The WWTP discharge is a negligible volume and contaminant contributor to water quality in the much larger Wairoa River estuary, and has not been shown to cause adverse effects except perhaps in the immediate vicinity of the discharge diffuser (LEI, 2017:A3I1a). The upstream farm and geological sources far exceed the WWTP contributions.

Further to the influences on the Wairoa River and its catchment, the NPSFM outlines the water quality limits set for each fresh water management unit and are implemented by the Hawke's Bay Regional Council (HBRC). These must include specific parameters as a minimum, and generally require attainment of national bottom line water quality values within set timeframes. Although HBRC have implemented water quality targets for the river (in the RRMP) and seasonal monitoring of waterways, the drive to improve the Wairoa Catchment and water quality has come from the community and local hapu. During a public meeting in August 2017 this was made clear to WDC who have agreed to take action to improve the catchment. Although this catchment aspiration has a large focus, beginning with implementing a sound and robust wastewater discharge design that is culturally acceptable will make a contribution to improving the health of the catchment.

Physical Geography of the Wairoa River Catchment

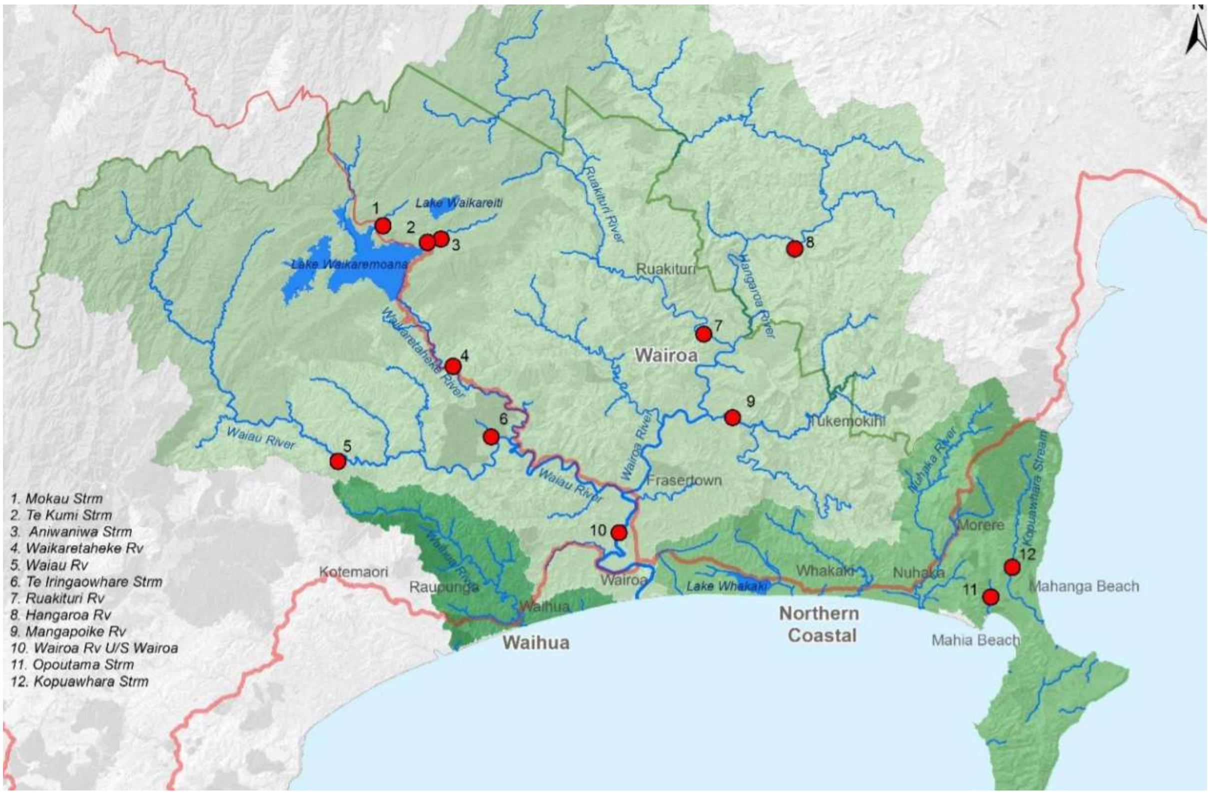

Figure 13.1 Wairoa River catchment

Main Rivers

The main rivers in the catchment are the:
Waiau River;
Waikaretaheke River;
Ruakituri River;
Hangaroa River; and
Wairoa River.

Waiau River - The Waiau River is located at the western side of the Wairoa catchment. Waiau translates to river of swirling currents. It is characterised by a mainly straight and fast flowing river with a stony bottom. The Waiau River is an important habitat for the Long Fin Tuna and the Blind Eel (koro koro).

Waikaretaheke River - The Waikaretaheke River is located below the outlet of Lake Waikaremoana in the northern catchment of the Wairoa River. The upper part of the catchment is in the indigenous forest of Te Urewera. Taheke waterfall is located at the spring where the water of Lake Waikaramoana flows into the Waikaretaheke River.

Hangaroa and Ruakituri Rivers - The north-eastern catchment of the Wairoa River is formed by the confluence of the Hangaroa and the Ruakituri Rivers, which meet at Te Reinga Falls. The upper part of the catchment is in the indigenous forest of Te Urewera. Significant characteristics are the big boulders in these rivers.

Wairoa River - Some remarkable aspects of the Wairoa River are the large area of indigenous vegetation and Lake Waikaremoana in its headwaters, and the shape and the tidal influence in its estuary which reflect the shape of the Whakamahi and Ngamotu Lagoons. The Wairoa River Catchment is dominated by pastoral vegetation, mostly high producing. Native cover makes up 45% of the catchment and is mostly located within Te Urewera (Figure 3).

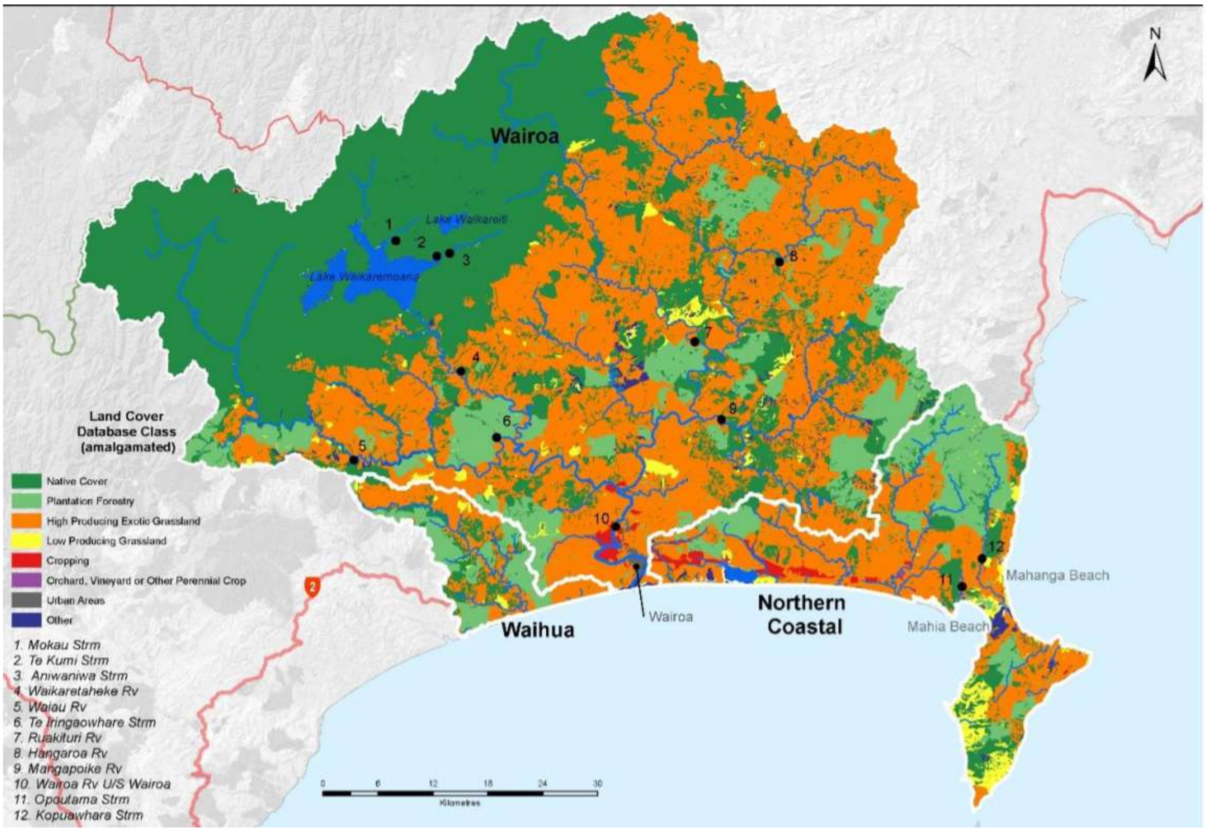

Figure 13.2 Wairoa and Northern Coastal land cover.

To assist with a further understanding of the catchment, it can be characterised by land cover, which is:

Native Cover 45%
Plantation forestry 9%
High producing 41%
Low producing 1%
Orchards/Vineyards 0%
Cropping 0%
Urban areas 0%

The native cover includes:
Broadleaved Indigenous
Hardwoods
Depleted Grassland
Fernland
Herbaceous Freshwater Vegetation
Herbaceous Saline Vegetation

Indigenous Forest
Manuka and/or Kanuka
Matagouri or Grey Scrub
Sub Alpine Shrubland
Tall Tussock Grassland

Investigations to Date

Background information that assists with identifying a best practicable option for the future of the Wairoa WWTP discharge includes consideration of:
The existing reticulation network;
Wastewater treatment;
Water impacts;
Land impacts;
Tangata whenua aspirations and obligations;
Community values; and
Planning considerations.

These considerations have to varying degrees been captured in a series of reports and memos prepared by the Wairoa District Council and their advisors.

Opus International Consultants have provided reports outlining wastewater modelling of the reticulation network to identify overflow and pump station issues. Good Earth Matters are also undertaking an assessment of the reticulation system between and including the Kopu road pump station and connecting pipework which has been identified as the reticulation catchment that is most prone to groundwater and stormwater entering the reticulation. The WWTP has had a geotechnical assessment of the pond structure and surrounding area undertaken by LDE Gisborne. This report concluded that the geomorphology of the pond site is fundamentally stable. The hillsides to the north of the ponds show some evidence of past shallow to moderately deep-seated land slippage. The slopes directly north of the secondary pond have been improved with buttressing and the steeper elevated slopes are isolated from the ponds, therefore are not likely to cause geotech issues. The slopes to the south from the secondary pond have minimum factors of safety (>1.5) under fully saturated conditions and >1.0 under seismic loading, these are above the minimum accepted factors of safety (LDE,2017). The WWTP is performing adequately to treat the wastewater to an acceptable standard despite flows being elevated by groundwater and stormwater entering the reticulation.

Investigations identifying impacts on the estuary environment from the current discharge included two reports by EAM Consultants. A key finding of environmental monitoring is that there is no scientific evidence of any adverse effects on the Wairoa River water quality or estuarine ecosystem health as a result of the discharge of treated wastewater. These reports also highlighted that the diversity of species within the Wairoa River is low at both the discharge site and upstream of this site. The trend over time has indicated species richness has declined from previous surveys conducted in 1996 and 2007. What is not clear is whether the background environment is contributing to the current observations. Land use and other discharges, such as stormwater may be influencing water quality (LEI, 2017:A3I1a).

From recent public meetings in August 2017, all parties acknowledge that the discharge into the Wairoa River is culturally offensive and needs to be modified prior to lodging the application to replace the discharge consent in 2018/19. Land discharge is a culturally acceptable alternative, and this is the sole reason for identifying and assessing a range of land treatment options for Wairoa.

Land investigations have included investigating areas around a 10 km boundary of Wairoa that are suitable for irrigation of wastewater, the associated likely costs of this and the current investigation into HRLP and RI sites. Including land as a treatment method has been widely acknowledged from the community and also reflects tangata whenua values. To explore this further, Nigel How has completed a draft report that represents a Maori worldview of wastewater within Wairoa. This will be followed with a cultural impact assessment once a best practicable option (BPO) has been established. A values report was produced that outlined the cultural, environmental, financial and recreational/social aspects that have been considered with identifying the HRLP, RI and further discharge options that have been considered for Wairoa.

These values feed into assessments of the discharge options and wider catchment scenarios. Other reports include information relating to natural hazard implications and, planning considerations including, but not limited to, the New Zealand Coastal Policy Statement 2010 ("NZCPS"); National Policy Statement for Freshwater Management 2017 ("NPS-FM"); National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health 2011 ("NES-CS"), HBRC's Regional Policy Statement ("RPS"), Regional Resource Management Plan ("RRMP"), and Regional Coastal Environment Plan ("RCEP"), WDC's Wairoa District Plan ("WDP") and Reserve Management Plans, and DoC's Conservation Management Strategy: East Coast Conservancy ("CMS-ECC"). These planning documents will allow further refinement of a selected option. Understanding these planning policies, objectives, and rules, particularly within the coastal environment, will assist with identifying an appropriate treatment and discharge system . It is important to understand what aspects of a system will require authorisations and how difficult those authorisations might be to obtain from the relevant regulatory authorities.

Appendix B

Soil Drainage Test Methodology & Results

Soil Drainage Test at Whakamahia Beach

Purpose

The purpose of the soil drainage test was to find out how fast the water infiltrates the sandy gravel foreshore soils at Whakamahia Beach. This information is critical for determining the potential discharge rate and suitable land area for a possible installation of a rapid infiltration basin in this locality for the future discharge of Wairoa WWTP's treated wastewater.

Place of testing

The infiltration test was implemented at the western end of the Whakamahia Lagoon, 39° 4'6.23"S and 177°23'17.31"E on 15 September 2017, as shown on Figure 1 below. The testing location was chosen by finding the most characteristic soil for the area without any plant or driftwood influences. The majority of the area contains coarse sand and small to fine gravel with a typical particle size < 10 mm, and occasional pebbles or cobbles up to about 200 mm in size. Some parts of the beach, particularly between the road and the highest reach of storm waves, are covered by plants and their roots. Below the high tide mark, driftwood including logs is scattered across the beach surface and embedded into the gravelly sand. The place of testing was selected based on being clear of all plants, roots or driftwood.

Another limiting factor for the test site location was the beach access, as it was not possible to enter the beach further than approximately 30 m off the road by car due to its soft and steep sandy terrain with frequent driftwood.

Figure 3 Location of drainage test site

Infiltration Testing Methodology

The following testing materials were used to measure the infiltration rate of the soils at this site:

- 1000l Water tank
- 600 mm PVC Pipe
- Tape measure
- Plastic bag
- 100 mm PVC pipe
- Stop watch

The testing apparatus was set up approximately 30 m off the road on a spot clear of vegetation and driftwood but with the typical soil condition for the area. Approximately 150 mm of topsoil was removed from the surface to remove driftwood and contaminants. The 600 mm PVC pipe was placed vertically in the shallow hole and the outside of pipe was filled up with soil to the original level. The bottom of the hole was smoothed and covered with a plastic sheet to seal the soil surface. A tape measure was attached to the inside wall of the pipe to measure the water level inside the pipe.
After the pipe was set up the water in the 1000 L tank was used to fill the 600 mm PVC pipe. After the water reached the level of approximately 200 mm the plastic sheet was removed and the water level started to fall as it drained through the soil below. Two infiltration rate measurements were made of the falling water level starting at 150 mm deep and two starting at 100 mm deep. The time was recorded from the point the water level reached the starting point till the water disappeared into the soil.


Figure 4 Set up of drainage testing apparatus

Error Considerations

Potential errors include turbulence on the water surface, as the removal of the plastic sealing sheet from the bottom of the infiltration pit caused turbulence. These waves made it difficult to assess the exact water level at the starting time.
Another error is the uneven bottom of the infiltration pit. The bottom of the infiltration pit lost its smooth structure through the turbulence in the water following removal of the plastic sealing sheet, and that made the exact point of the end of the infiltration time measurement hard to assess.
The number of tests was two replicates for each initial water level, which has a statistically lower level of reliability than three replicates. However, the consistency of the results indicated that this was not a concern in this test series.

Results

Measurement	Initial Water Level (mm)	Drainage Time (s)	Drainage speed (mm s^{-1})
1.	100	22	4.5
2.	100	22	4.5
3.	150	33	4.5
4.	150	33	4.5

Within the set of drainage tests on 15 September 2017, the results are all very consistent with each other.
The drainage speed is calculated by:

$$s = \frac{\Delta l}{\Delta t}$$

Based on this calculation method, the infiltration rate is 4.5 mm s^{-1} or 16,000 mm h^{-1}.

Discussion

The range of possible values for infiltration rates are classified by Tidemann (1996) as follows:

- low infiltration rate: < 15 mm h^{-1}
- medium infiltration rate: 15 to 50 mm h^{-1}
- high infiltration rate: > 50 mm h^{-1}

The infiltration rate measured at Whakamahia Beach on 15 September 2017 is therefore extremely high, as it is more than 300 times faster than a medium infiltration rate
Within the infiltration rate of 16000mm*h^{-1} the infiltration rate is between the values for sand (633.13 mm*h^{-1}) and gravel (570956 mm*h^{-1}) (Morcom, 2013).
That fits to the rough sand/gravel texture at the Whakamahia beach.

Appendix

Table 2 Typical saturated hydraulic conductivity (Ksat) for different textural classes.

texture	K_{sat} (m/yr)	K_{sat} (mm/hr)
Sand	5550	633.13
Loamy sand	4930	562.4
Sandy loam	1090	124.3
Silty loam	227	25.9
Loam	219	24.98
Sandy clay loam	199	22.7
Silty clay loam	53.6	6.11
Clay loam	77.3	8.82
Sandy clay	68.4	7.82
Silty clay	32.1	3.66
Clay	40.5	4.62
Rock	5.0005	0.57
Gravel	5005000	570956

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