# Wastewater Discharge to Land

## Good Practice Guidance

Prepared for Far North District Council
Prepared by Beca Limited

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## Revision History

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## Document Acceptance

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| on behalf of | Beca Limited | | |

# Contents

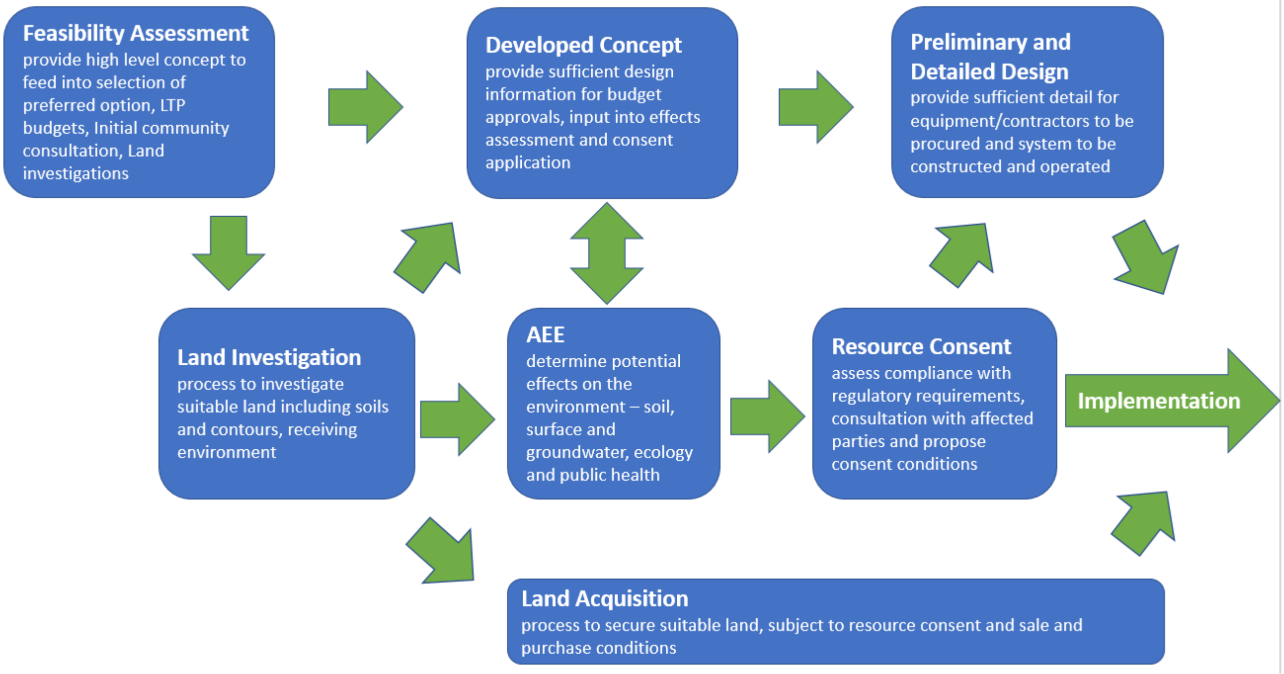
# Executive Summary

Over the next several years Far North District Council (FNDC) has a number of Wastewater Treatment Plant (WWTP) resource consents expiring. As part of investigations required to support any new resource consent application, Policy D.4.3 of the Proposed Regional Plan for Northland (Appeals Version – October 2021) sets out that an application for resource consent to discharge municipal wastewater to water will generally not be granted unless, among other things, a discharge to land has been considered and found not to be environmentally, economically or practicably viable.

The overall purpose of this document is to provide high-level guidance document for FNDC to implement following on from the desk-top GIS investigations completed internally, from concept design, environmental investigations, consent lodgement, preliminary design, detailed design and commissioning.

Given the above, this guideline aims to provide structured guidance to FNDC but also recognise that WWDTL projects can vary in their complexities dependent upon local environmental conditions and tāngata whenua/stakeholder engagement outcomes.

Various levels of information are required at different stages of the implementation of WWDTL schemes to inform decision making, regulatory requirements and allow implementation.  The general process is described below in the below Figure.




In general terms, as the project becomes more defined from feasibility through to detailed design, the range of the cost estimate will decrease. At the early project stages significant contingency sums are provided to allow for unknowns during design and construction. As the design progresses these contingency sums reduce but are still required up to and including constructing.

Tāngata whenua should be engaged from the start of a WWDTL project along with other key stakeholders. Whilst a successful WWTDL project would divert treated wastewater away from surface water receiving environments, potential effects on sites of cultural significance from the process of discharging wastewater to land could result depending on location and methodology.

There is no one size fits all approach for tāngata whenua and stakeholder engagement. It is recommended however that engagement starts early, an engagement plan is developed that becomes a living document throughout the project and a comprehensive audit trail is maintained throughout the process to record key engagement activities and outputs.

It is important to consider internal stakeholders alongside external parties. It is particularly important that operators of the future WWTDL system are involved in the design to ensure they have inputs to the design process through concept and detailed design.

# 1 Introduction

Over the next several years Far North District Council (FNDC) has a number of Wastewater Treatment Plant (WWTP) resource consents expiring. As part of investigations required to support any new resource consent application, Policy D.4.3 of the Proposed Regional Plan for Northland (Appeals Version – October 2021) sets out that an application for resource consent to discharge municipal wastewater to water will generally not be granted unless, among other things, a discharge to land has been considered and found not to be environmentally, economically or practicably viable.

Generally speaking, there is a desire from tāngata whenua for treated wastewater to pass through land before it reaches a water body.

Given these regulatory and cultural drivers, FNDC has developed an internal methodology to assess Wastewater Discharge to Land (WWDTL) land options for each WWTP site using desk-based GIS analysis. This GIS analysis seeks to identify a short-list of potential discharge to land sites for further investigation.

# 2 Purpose

The overall purpose of this document is to provide high-level guidance document for FNDC to implement following on from the desk-top GIS investigations completed internally, from concept design, environmental investigations, consent lodgement, preliminary design, detailed design and commissioning.

Beca's experience working across New Zealand has shown that each WWDTL project is different, reflecting not only local receiving environments, geography, climate but also tāngata whenua and stakeholder preferences and desires. Engagement is usually an iterative process that precedes key milestones in WWDTL projects, particularly with landowners and tāngata whenua.

Given the above, this guideline aims to provide structured guidance to FNDC but also recognise that WWDTL projects can vary in their complexities dependent upon local environmental conditions and tāngata whenua/stakeholder engagement outcomes.

# 3 Potential Land Discharge Systems

The drivers towards land discharge schemes in New Zealand have been fostered since the advent of the Resource Management Act 1991 (RMA), as set out in Section 5 of this report. Discharge of treated wastewater to land can provide further treatment by several processes including physical filtering, chemical reactions and biological breakdown as the treated wastewater passes through the soil. The treated wastewater is dispersed via different processes: assimilation through the soil for eventual plant uptake of soil moisture, evaporation, and percolation through the soil for assimilation with groundwater with subsequent discharge to surface water[1].

In New Zealand, various land discharge systems have been used depending on site conditions, soil type, land use, land slope, climate, and nature and volume of the discharge. In general, land-based discharge systems can be categorised into the following groups:

- Slow Rate Irrigation
- Rapid Infiltration
- Overland Flow
- Land Passage
- Deep bore injection
- Mixed Discharge Systems

This section provides information on potential land discharge systems for discharge of treated wastewater.

## 3.1 Slow Rate Irrigation

Slow Rate Irrigation is a controlled discharge of treated wastewater at a low rate to a vegetated land surface. In the slow irrigation process, treated wastewater infiltrates from the vegetated soil surface and flows through the plant root zone where supplementary treatment is provided by soil and plants by using essential nutrients for plant growth. This irrigation method is the most widely used form of land treatment[2].

If irrigation systems minimise losses to groundwater, systems can operate as a soil-moisture deficit irrigation system. However, if there are some losses to groundwater, irrigation systems can operate as a soil moisture non-deficit system. Depending on site conditions and wastewater characteristics, different discharge methods such as spray, border dyke or subsurface drip systems can be used.

Compared to the other land treatment concepts, slow rate irrigation needs the largest land area. Due to the high land requirements and the cost of reticulation and discharge systems, slow rate irrigation is more expensive than other land discharge systems. However, the commercial use of end products can offset part of the cost in some cases. Internationally, slow rates irrigation discharge systems have been used in thousands of systems. In New Zealand, Taupō, Whangamata, Foxton, Masterton, Leeston and Rolleston are just some examples using treated wastewater for irrigation in variations of the slow rate irrigation process[3].

[1] On-site Wastewater Management in the Auckland Region, Auckland Council, 2021.

[2] Wastewater Technology Fact Sheet, EPA, 2002.

[3] The New Zealand wastewater sector, Prepared for Ministry for the Environment, 2020.

Figure 1 - Slow Rate Irrigation using a centre-pivot irrigator

## 3.2 Rapid Infiltration

Rapid infiltration is one of land discharge techniques that uses the physical soil environment to treat wastewater. Compared with other treatment methods, a much larger volume of wastewater on a much smaller land area can be discharged in rapid infiltration. In this system, wastewater is applied to earthen basins on high permeability soils and infiltrates through the soil matrix to a water body or is recovered by subsurface pumping. The role of the vegetation cover for nutrient uptake is insignificant in rapid infiltration systems due to lack of contact time between plants and wastewater. Rapid infiltration systems tend to be less expensive than slow rate irrigation due to the smaller land requirements; however, they need deep and permeable deposits of highly porous soils. Where the quality of the nearby water bodies (rivers, lakes, aquifers) is critical, a high-level design of rapid infiltration systems is required with potential implications for higher quality treated wastewater. Moreover, in these systems, when the discharge of treated wastewater to land is exposed to sunlight, scarification of the surface layers of the media should be done to remove algal growth.

Examples of rapid infiltration application in New Zealand are the infiltration beds in Motueka, rapid infiltration beds at Cambridge (photo below), Te Paerahi (Central Hawkes Bay) and infiltration trenches in Rotoiti-Rotomā.

Figure 2 - Te Paerahi, Central Hawkes Bay (rapid infiltration discharge area is the green vegetated area to the left of the photo)

## 3.3 Overland Flow

Overland flow is the discharge of wastewater to gently sloped and grassy land areas. Relatively impermeable soils are used in these systems and therefore the infiltration is low. As the wastewater flows over the soil surface in a thin film, it receives treatment by the soil and vegetation interaction. Wastewater runoff is collected by ditches at the bottom of the slope, and the treated wastewater can be reused or discharged to a surface water body. Vegetation in overland flow systems plays a key role. Slope stability, erosion control and treatment are provided by perennial grasses. Overflow can remove BOD and suspended solids by biological oxidation, sedimentation, and filtration processes. Moreover, nitrogen can be removed by plant uptake, denitrification and ammonia volatilization. A typical diagram of overflow land treatment is shown in Figure 3 below[4]. Oamaru and Otaki wastewater discharge schemes in New Zealand have used overland flow systems for wastewater treatment in the past.

[4] Bhargava, A. 2016. Land Treatment as Viable Solution for Wastewater Treatment and Disposal in India.

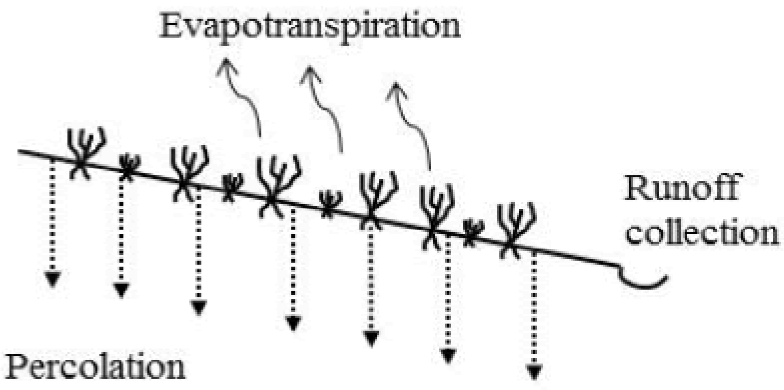



Figure 3 – Overland Flow Treatment

## 3.4 Land Passage

Land passage techniques have been designed as an alternative to direct discharge of treated wastewater to surface water and incorporate Māori cultural considerations regarding not disposing human waste directly to waterbodies. As general Māori cultural view, wastewater should be restored in Papatūānuku (mother earth) before entering a water body. In these systems, wastewater flows through or over stone or rock beds prior to discharge to waterways.

Examples of cases that have implemented land passage systems in New Zeeland are Morrinsville, Hastings, Napier, Te Awamutu and Te Puke wastewater schemes.

Figure 4 – Te Awamutu rock passage under construction (approximately year 2000)

## 3.5 Deep Bore

Deep bore injection of treated wastewater is a potential method for disposal of wastewater. In this method, wastewater is pumped into the subsurface using deep bores. The deep bores place wastewater underground into porous geological formations at a depth that reduces the risk of pollution of groundwater which is used for drinking water or surface water. The geological formations may range from deep sandstone or limestone, to a shallow soil layer.

The township of Russell is the only example in New Zealand that has applied deep bore injection for discharge of treated municipal wastewater, although in this case the treated wastewater is discharged into shallow bores rather than deeper bore systems.

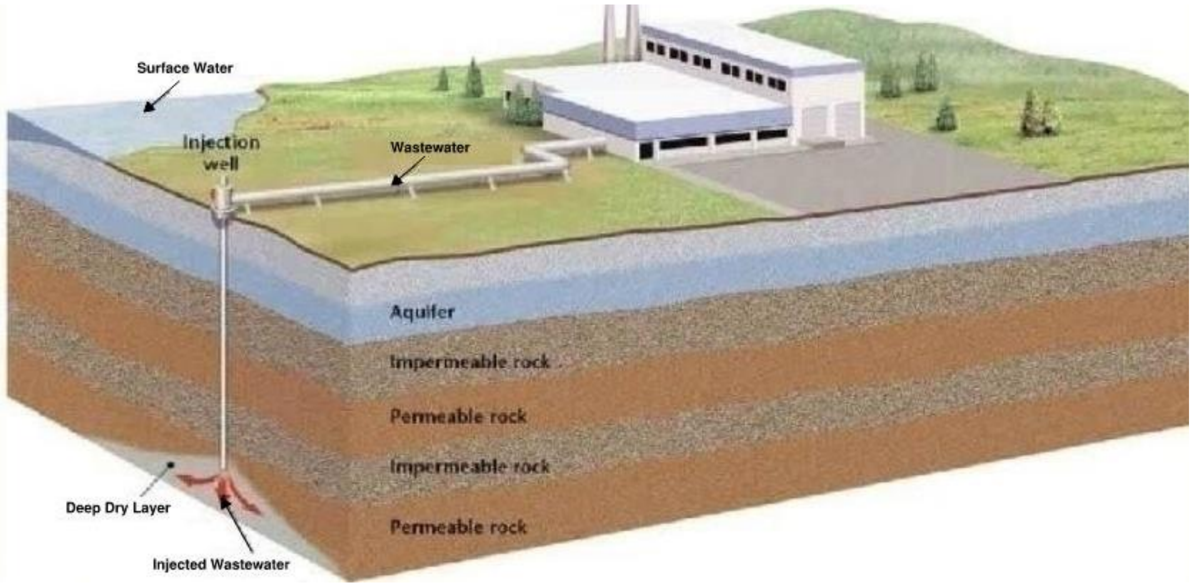



Figure 5 – Deep Bore Injection[5]

## 3.6 Mixed Discharge Systems

A mixed wastewater discharge system is used where different land-based discharges are used simultaneously for discharge of wastewater or a land-based system is used for some parts of the year and wastewater discharge goes to surface water for the rest of the year.  A mixed discharge system has been adopted for discharge of wastewater in Blenheim which benefits land by providing wastewater for irrigation during the dry months.  In Feilding discharge to land during the summer months reduces impacts when the Oroua River is generally low and produces a saleable product.  Soil conditions are not suitable for year round irrigation at the Feilding site.

## 3.7 End Use Considerations

Increasingly, WWDTL systems ae being seen as methods to beneficially reuse wastewater and recover nutrients through irrigation benefit.

Early examples in New Zealand, such as the Rotorua Land Treatment System, irrigated treated to wastewater to pinus radiata plantations with the assumption that tree growth would benefit. This has occurred, however the faster growing trees has also led to lower quality wood.

More recently, beneficial reuse options have included the implementation of cut and carry systems where grass grown can be harvested, sold as a marketable product and fed to non-dairy stock. The most successful example of this is the Taupo Land Treatment System.

[5] https://slidetodoc.com/chapter-19-waste-12-1-solid-waste-a/

In other examples, treated wastewater can be applied to farms where non-lactating beef cows are grazed (Fonterra policy currently prohibits the discharge of treated wastewater to land grazed by lactating dairy cows) or non-food crops are grown. There are several examples of land treatment systems such as this in the lower North Island. Potential end use considerations and example sites are shown further in Table 1.

Table 1: Potential End Use Considerations and Examples

| Activity | Examples Sites | Irrigation Methods | Considerations |
|---|---|---|---|
| Golf course | Omaha<br>Kinloch | Sub-surface drip<br>Sub-surface drip | Surface spray is used in Australia and America, but only with highly treated and disinfected wastewater. |
| Forestry | Whangamata<br>Rotorua | Surface spray<br>Surface spray | Lower quality wood if irrigation and nutrient rates are too high.<br>Nutrient loss rates can increase over time. |
| Dairy farm (lactating cows) | None | N/A | Fonterra does not permit farmers to feed material to lactating cows with human wastewater that has not been treated in accordance with the 'Californian Standard – Title 22'.[6] |
| Cut and carry (fed to dry stock) | Taupo | Centre Pivot | Large areas of flat land required. |
| Stock feed | Takapau, Porangahau (Central Hawkes Bay) | Surface spray | Withholding periods apply following irrigation with wastewater – typically at least 48 hours between irrigation and grazing animals or harvesting crops. |
| Horticulture | Under research | Dripper lines situated under mulch layer. Examples include kiwifruit and avocado. | Further work required to determine requirements of relevant industry bodies (e.g. Ministry of Primary Industries and Ministry of Health). |
| Manuka/Kanuka for honey | Under research | Surface spray or dripper lines | Further work required to determine requirements of relevant industry bodies (e.g. Ministry of Primary Industries and Ministry of Health). |

[6] https://nzfarmsource.co.nz/assets/Resources/Dairy-Diary/Fonterra-Farmers-Handbook.pdf

# 4 Implementation Steps

Various levels of information are required at different stages of the implementation of WWDTL schemes to inform decision making, regulatory requirements and allow implementation. The general process is described below in Figure 1 and described at a high-level in in the sections following.

## 4.1 Feasibility Assessment

At this stage the existing WWTP flows and effects are reviewed and assumptions made around future demand (based on future population and commercial/industrial growth projections). A range of feasible high level options are developed for the future which may include land discharge options. The options will describe a high level concept for the treatment and discharge elements of the proposed scheme. Potential areas suitable for land disposal will be identified from readily available information in Council's GIS system and publicly available databases (e.g. soil maps) and we have assumed that such work has already been undertaken by FNDC for each wastewater scheme. To develop the capital and operational costs for this stage an indicative land discharge location will be assumed, key infrastructure components (e.g. pipeline length, land irrigation area)sized and costs developed with +/-50% accuracy (Class 5).

An MCA is often used at this stage to assist with selecting the preferred option.

To identify risks associated with the physical characteristics of a site and regulatory overlays, desktop assessments should be undertaken prior to the selection of a short list of sites to identify the range of site requirements to sufficiently inform high level concepts and costs. By applying this first filter we can concentrate effort on where sites are most likely to be suitable. The criteria used by FNDC are:

- Distance from WWTP
- Slope
- Distance from houses and schools
- Buffer around waterways and property boundaries
- Soil drainage class
- Vegetation cover
- Flood zones
- Heritage (NZAA sites and statutory acknowledgement sites/overlays are mapped however mana whenua engagement is also required in relation to cultural heritage aspects of sites).
- Recorded water abstraction sites including bores

Other criteria that could be considered if information is available are:

- Distance from shallow groundwater and surface water takes
- Slope stability
- Proximity to electrical supply
- Mapped sites of significance (i.e. outstanding landscape), and relevant Regional and District plan mapped layers?

**Resources required:** FNDC internal staff and GIS

**Timing:** 3-4 months

**Inputs** – include GIS layers, current WWTP flows and treated wastewater quality, historical compliance reports, assumptions on soil and infiltration properties

**Outputs** – Basis of design (future flows and loads), key assumptions, High level cost estimate, potential land discharge sites, indicative area required for land discharge, potential issues/risks

## 4.2 Land Investigation

Once a preferred option is selected, a site or sites are investigated to confirm they are available for purchase or lease and suitable for land discharge.

A specialist property consultant is often used at this stage to negotiate property access and potential sale and purchase/lease agreements.

Land investigations include site specific soil testing, infiltration testing, surrounding environment high level assessments to confirm assumptions made in the feasibility stage.

This stage includes a preliminary planning assessment to determine potential resource consent issues and identify relevant stakeholders to engage in consultation.

Site investigations are required to determine soil type, drainage and the presence of any limiting layers (that would cause subsequent drainage issues). These investigations can also determine groundwater levels and potential hydrogeological conditions under the site in consideration. These investigations aim to determine the appropriate irrigation rate of wastewater to land and potential limiting factors such as soil moisture and groundwater levels. These investigations should also assess slope and areas of sites where irrigation may not be practicable due to issues such as excessive slope, springs, historical slips or within close proximity to surface waterways.

**Resources required**: Geotechnical engineer and/or soil scientist

**Timing:** 2-3 months

**Inputs** – Feasibility stage report, permission to test on private properties, information from regional council

**Outputs** – Land suitability assessment, potential options for acquisition, high-level planning assessment.

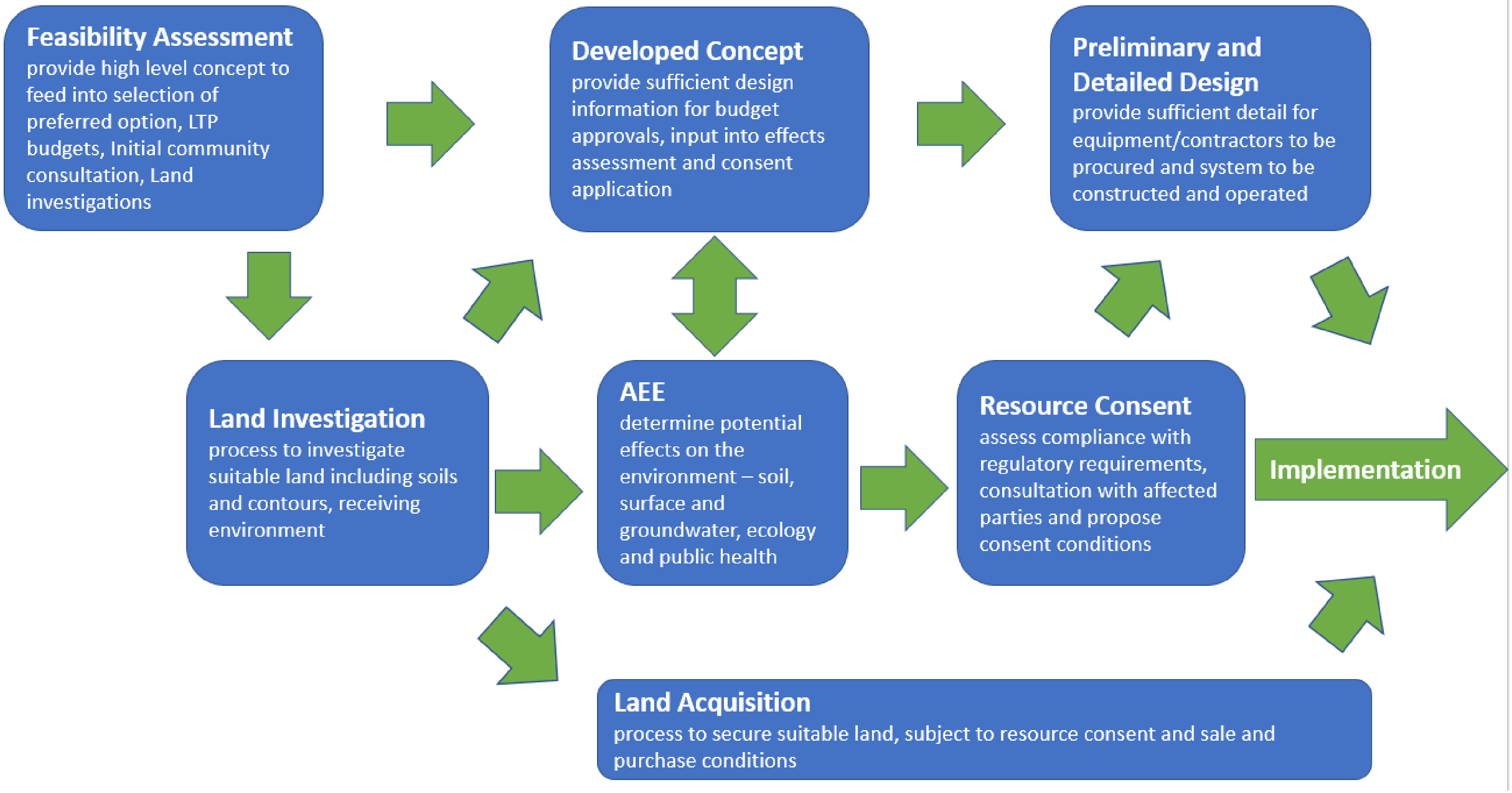



Figure 6 - Land discharge flow chart

## 4.3 Developed Concept

Once a site is confirmed, the concept can be developed further so there is sufficient information to allow the assessment of environmental effects and resource consent application to be prepared. A Preliminary planning assessment confirming likely resource consent requirements and standards would be undertaken at this stage to help inform the range of environmental investigations needed to support the design process.

This can be an iterative process because if an effect is identified that could be of concern, changes to the design concept may be needed to be mitigated.

At this stage the engineering details would include:

- Any treatment upgrades required to service growth or improve treated wastewater quality
- Any filtration required prior to transfer to irrigation system (to avoid blockages)
- Pump station sizing (size of wet well and indicative pump selection)
- Indicative pipeline route, size and pressure rating and identification of any features that would impact on costing (e.g. stream/main road crossing)
- Storage pond location and dimensions (if required)
- Geotechnical soil testing – soil type and infiltration testing
- Land discharge area irrigation system concept (type of irrigation and planting)
- Areas to be used for buffers
- Assessment of electricity use and labour inputs
- Any other services required such as utilities– water, electricity or telemetry
- Assessment of Green House Gas (GHG) emissions (optional) – capital and operational
- Operation and Maintenance (O&M) practices to mitigate any potential effects
- Risk assessment/Initial Safety in Design review
- Updated cost estimate (capital and operational)

**Resources required**: Environmental/Process Engineer, Civil Engineer, Electrical Engineer, Mechanical Engineer, Planner, Quantity surveyor

**Timing:** 3-6 months

**Inputs** – Selected site, Confirm basis of design (future flows and loads), operational preferences, level of contingency e.g. for storage pond, sustainability/climate change requirements

**Outputs** – Concept Design report with cost estimate +/- 25% (Class 4)

Throughout New Zealand, different land-based discharge systems have been used depending on the specific conditions of the site and the nature of the discharges. As outlined in Section 2, systems can be grouped into the following categories based on the application to land type:

- Slow rate
- Rapid infiltration
- Overland flow
- Land passage
- Deep bore injection

- Mixed systems

Factors influencing land based discharges feasibility include:

**Flow and loads** – WWDTL schemes need to be designed to service residential and non-residential growth. Information is available via census, rating databases and district plan zones. Inflow and Infiltration (I&I) will also have an impact on the peak volume for conveyance and the total treated wastewater flows to be discharged to land. Other impacts on flow and load can be seasonal fluctuations due to holiday populations and wastewater composition relating to trade waste discharges. It is important to understand the current and future flows and loads and document these in the basis of design.

**Nature and volume of the discharge:** Usually there is a lower or no agronomic requirement for irrigation during winter as the soil moisture is higher and plants are not actively growing. The greatest benefits from irrigation are achieved during the drier months when there is a higher water demand, however treated wastewater needs to be discharged during the whole year. In some situations, to achieve 100 per cent land discharge, storage of wastewater may be required so it can be applied to the land when it is actually needed and to avoid environmental effects. The storage required may be very large making this alternative less viable. For example, at the Mangawhai scheme, with an average daily flow of approximately 1ML, storage of 180ML is required.

**Soil type:** The soil permeability in the area where the discharge is to be applied is a fundamental factor for a successful system. The hydraulic capacity of the soil is a limiting factor for the volume of the discharge and hence determines the amount of land area required. Some soils are only suitable for deficit irrigation – irrigation can only occur when there is a soil moisture deficit. Long residence times for wastewater in soil, leading to anaerobic conditions, need to be avoided. In low permeability soils runoff also is likely to occur if application continues after saturation is reached. Topsoil depth should be sufficient to allow plant root development. The nature of the sub-soil minerals will also determine the amount of phosphorus that can be absorbed.

**Land slope:** The topography of the land to be used for wastewater discharge is an important consideration. Steep slopes may induce to higher soil erosion and runoff, and slope stability may become compromised under saturated conditions. Ideally irrigation would be carried out on slopes less than 15 degrees. 26 degrees is recognised as the maximum safe slope for regular irrigation to avoid surface run-off and the risk of serious erosion. Land slope will also dictate the plant species to be used, the harvesting frequency and treated wastewater distribution system type to be implemented.

**Climate:** The climatic conditions are important when determining the likely feasibility of land based discharges in a particular area. Temperature has an effect on microbial activity in soil, which is reduced at lower temperatures. A soil can get saturated under high rainfall conditions, which will restrict the infiltration capacity and soil aeration. Land-based discharge systems should be designed take into account the particular conditions of temperature, wind intensity and direction, evapotranspiration and rainfall of the site. Automated weather stations with long rainfall and soil moisture data history are useful for modelling the required irrigation storage if deficit irrigation is undertaken.

**Groundwater:** The distance between the soil surface where the wastewater is applied and groundwater levels is important to minimise the risk of contaminants reaching groundwater. A high water table also plays a role in plant growth by limiting root development. The distance to groundwater bores to be used as a water source or for other purposes becomes relevant when wastewater is being applied to land, and suitable mitigation measures need to be taken to minimise the risk of contamination of groundwater sources.

**Surface water:** Buffer zones are generally established for sites receiving wastewater discharge to help prevent surface runoff and nutrient migration to water either directly or via ephemeral water courses. Surface water can be affected by eutrophication if high levels of nutrients from wastewater reach them. In particular, phosphorus tends to accumulate in the topsoil and can get into waterways by soil erosion. Strong winds can also cause treated wastewater to reach surface water when sprinkler irrigation is used, so an adequate distance to waterways is required.

**Land use:** The distance from residential areas and public spaces (roads, footpaths, parks, cycle trails etc) to the site to be used for wastewater discharges and storage ponds should be enough to minimise the risk of contact between the community and the treated wastewater, and also to avoid nuisances such as odour and spray drift. In general, buffer zones are used to ensure an adequate distance is achieved, however the selection of a site may cause strong opposition from neighbouring residents who may be affected by odour and adverse amenity effects.

**Distance to land discharge areas:** The distance from the wastewater treatment plant to the discharge site is a key factor to consider in selecting a land disposal area due to the potentially high impact on capital and operational costs. Higher energy and pumping costs are associated with longer distances, and pipeline construction costs are increased. The elevation difference may become a factor that impacts ongoing energy costs and GHG emissions. Other considerations include stream and highway crossings, air valve and scour valve locations.

**Revenue:** When selecting the land application type, the economic benefits to be obtained from potential crops also play a role. There is a potential profit to be obtained by using plants with a productive value. Yet, there is a risk of a negative market perception with respect to the use or acceptability of produce grown using treated wastewater. There are some examples in New Zealand (e.g. Taupo and Feilding) where revenue is derived from the hay harvested from the land treatment system. Management of tree irrigation has also evolved over time to reduce any impact on wood quality.

**Industry requirements:** In many cases there is productive land that meets most of the requirements for a land-based discharge, however there is little interest from the industry to accept the treated wastewater, as they are seen as a high risk product with arguable value. For example, no discharges are applied to pasture used for dairy production in New Zealand, which is likely to be a result of a rule set by Fonterra that requests wastewater to be treated to California Health Law Title 22 standards before it can be used (Cass & Lowe, 2016).

**Land tenure:** In many occasions one of the main factors influencing the ability to undertake land-based discharges is that land is privately owned, and the investment needed to acquire land makes the option non-practical. For larger cities, significantly larger areas of land are required. Land can be leased at lesser capital costs but this does not provide the ongoing long-term security of the land for the discharge of treated wastewater. All the factors listed above need to be considered when assessing the viability of adopting a land-based discharge scheme. In New Zealand, several feasibility studies have been undertaken to review the land available for treated wastewater discharges and their suitability, with results that vary considerably between communities depending on the local conditions.

## 4.4 Land acquisition

A specialist property consultant is often used at this stage to negotiate property access and potential sale and purchase/lease agreements. Council may have these skills in-house.

Land treatment systems in NZ operated by councils operate on both council owned land (purchased) and leased land. Land purchase provides long-term security as Council can control that land and the use of that land in perpetuity. Land use consents and/or designations can be sought more easily over land that is owned by the Council. A disadvantage of owning land is the capital cost in acquiring that land. If land is to be acquired a ‘willing seller/willing buyer’ process is much more preferable. The Public Works Act can be used to purchase land, however the compulsory purchase aspects are complicated. We are not aware of compulsory purchase being used in NZ for a land discharge system.

An alternative approach is to lease the land or access the land through the use of an easement. This results in lower capital costs, but does not provide the long-term security of using that land. Long-term leases are clearly preferable. It should be noted there are currently several examples in NZ of farms using dairy factory wastewater to irrigate land terminating leases, due to a number of factors, largely around managing stock and nutrient losses in winter, with the requirement to continue discharging wastewater to land.

Our view is that there is no 'one size fits all' approach to land acquisition and each situation should be considered on its own benefits and disbenefits.

**Resources required**: Property specialist

**Timing:** 12-18 months

**Inputs**: Long-list and/or short-list of properties

**Outputs**: Land Acquisition Strategy, Memorandum of Understanding, Land Sale and Purchase Agreements

## 4.5 Environmental Investigations

A number of environmental investigations are required to inform the potential effects of a WWDTL system and these can be very specific, but generally cover effects of the discharge on air, land, groundwater, surface water and ecology. These investigations and potential effects are further described in Section 7 of this document.

**Resources required**: Geotechnical engineer, hydrogeologist, surface water quality scientist, ecologists, air quality scientist, Environmental Engineer

**Timing:** 12-18 months

**Inputs**: Preferred site

**Outputs**: Reports from technical investigations, refinements to consent design

## 4.6 Assessment of Environmental Effects and Resource Consent Application

The Assessment of Environmental Effects (AEE) is the key document that supports a resource consent application for a WWDTL scheme. This document sets out how a WWDTL scheme will fit within the statutory framework for Northland as described in Section 5 of this document. Typical investigations that are included in an AEE are described further in Section 7 of this document.

There are typically two types of consents required for WWDTL schemes including:

1. Regional consents – for the discharge of contaminants to land (where they may enter water), air. These consents would be sought from the Northland Regional Council.
2. Land use consents – for the use of land and activities such as earthworks associated with the construction of the WWDTL site. A Notice of Requirement (NOR) can also be sought for a new designation. These consents would be sought from FNDC or using the Requiring Authority powers that FNDC holds.

In addition to the technical investigations required to support a resource consent application, engagement and consultation with tāngata whenua is required to identify and address potential cultural effects. Resource consent applications should be made following the completion of a developed concept design.

Where an application is subject to public or limited notification, a concise set of documents with easy-to-understand drawings is helpful to avoid a lengthy and submissions and hearing process (refer Section 5 of this report).

**Resources required**: Planner, Technical Specialists

**Timing:** 3-6 months

**Inputs –** Concept/Preliminary designs, preliminary planning assessment, consultation outcomes, environmental investigations / assessments;

**Outputs –** Assessment of Effects on the Environment (AEE), resource consent application, hearing evidence (if applicable), consent decision and accompanying conditions (if successful).

## 4.7 Preliminary and Detailed Design

Once a decision is received for the consent, the conditions are checked against the concept developed to check where these may influence the design. Risks from the developed concept stage are reviewed to determine if any further investigations are needed to inform the design (e.g. geotechnical testing at a stream crossing, potholing, service locations, survey).

A procurement strategy will determine which elements proceed through to preliminary and detailed design and which elements can be procured via a design build contract.

For design/build elements a performance specification is prepared to communicate to the provider the required functionality and components. This is often used for the irrigation pipework and controls which is a specialist service.

For civil and mechanical elements the design would proceed to produce drawings and specifications for:

- Detailed design of any treatment upgrades required to service growth or improve treated wastewater quality
- Detailed design of any filtration required prior to transfer to irrigation system (to avoid blockages)
- Pump station design (details of wet well, valving and pump selection)
- Pipeline design - long sections, size and pressure rating and details (e.g. stream/main road crossing)
- Storage pond plan and cross sections including liner requirements
- Provide details for any utilities required – water, electricity etc and for telemetry to integrate with Council's existing system
- Access and security details (gates, fencing etc)
- On-going risk review
- Safety in design assessment

**Resources required**: Environmental/Process Engineer, Civil Engineer, Electrical Engineer, Mechanical Engineer, Structural Engineer, Contractor for Design/Build elements or early contractor involvement in design

**Timing:** 6-9 months

**Inputs**: Consent conditions, requirements of other utilities

## 4.8 Outputs: Performance Specification and/or Drawings and Specifications (Issued for Tender), Implementation

The Implementation stage involves following internal Council processes for approval to tender and engaging contractors. This requires tender documents to be developed, tenders to be evaluated and contracts awarded. Once construction commences, construction supervision is undertaken to check construction is proceeding according to design and any issues found are resolved. Residual construction hazards identified during design should be communicated to the contractors to eliminate or control.

Once construction is complete the system is commissioned and as-built records, asset records, training and O&M manuals are provided. Residual operations hazards identified during design or construction should be communicated to the operations team to eliminate and control. Any environmental management plans required by the resource consent are prepared.

**Resources required**: Project Manager, Quantity Surveyor, Engineer to Contract and Engineer's Representative, Technical/Engineering support during construction, Communications advisors, Contractor, Operators (during training and commissioning)

**Timing:** 12-18 months

**Inputs**: Standard contract documentation and procedures, Drawings and Specifications (Issued for Construction), liaison with other utilities and operations staff

**Output**s: Tender and Contract documents, Engineer's estimate +/-10% (Class 2), As-builts, Asset records, O&M manuals, Environmental management plans

# 5 Regulatory Framework

The Resource Management Act 1991 is New Zealand's overarching statutory document, under which all National Policy Statements, National Environmental Standards, Regional Plans, and District Plans are developed and must give effect to. Within Far North District, wastewater discharges to land and water, as well as supporting treatment plant structures and assets, are subject to the RMA and the following regulations and standards set out in regulatory documents:

- National Policy Statements;
- National Environmental Standards;
- Proposed Northland Regional Plan July 2021 (Operative in Part, subject to appeals);
- Far North District Plan (2009).

These documents provide a hierarchical framework of standards, guidelines, enabling policies, and other requirements to achieve environmental and cultural outcomes while providing for the social and economic wellbeing of communities, as well as the health and safety of residents. Regulators must decide on an application for resource consent based on an objective review of all relevant planning documents and the provisions relevant to the activities.

As a result of the more recent statutory documents and recent Environment Court decisions, the impetus to investigate wastewater discharge to land schemes over the more traditional methods of discharges to water appears to result from two key drivers:

- More stringent water quality standards set out in the regulatory documents and Environment Court decisions; and
- More accountability to address cultural effects and involve tāngata whenua throughout decision making processes.

Based on recent experiences, determining and addressing cultural effects has proven to be more of a risk from a programme and reputational stance. Specific policies, provisions, and regulations that must be considered in determining a method for wastewater discharges have been identified in the following paragraphs.

## 5.1 National Policy Statements and Environmental Standards

National Policy Statements (NPSs) are used by central government to prescribe overarching objectives and policies for matters of national significance, relevant to achieving sections 5 and 6 of the RMA. These must be considered when a local government is preparing regional or district objectives and policies. Existing NPSs that are in effect and will likely apply to WWDTL schemes include:

- NPS for Freshwater Management 2020 (NPS:FM) – which sets bottom line ecological standards for discharges to freshwater bodies, including streams and lakes; and
- New Zealand Coastal Policy Statement 2010 (NZCPS) – which sets policies that pertain to the coastal environment, including the 'landward edge'. The definition of the 'landward edge' is not fully clear and is dependent on the local environment.

A Proposed NPS for Biodiversity is currently being drafted and a proposed draft has been in circulation since 2019. It is anticipated that this will go into effect by the end of 2021. The Proposed NPS for Biodiversity will focus on ecosystem health within terrestrial environments (*i.e.* environments not otherwise covered by the NPS:FM and NZCPS).

National Environmental Standards (NESs) are intended to provide consistency in the way technical standards are set and applied across New Zealand. These provide minimum standards that must be met, but also allow for local government bodies to mandate more rigorous standards if deemed necessary. Current NES regulations that are in effect and will likely apply to WWDTL schemes include:

- NES for Sources of Human Drinking Water 2007 (NES:DW) – where an activity located upstream of a water supply could have potential effects on the quality of that source;
- NES for Assessing and Managing Contaminants in Soil to Protect Human Health 2011 (NES:Soil) – as 'wastewater treatment' is identified as a Hazardous Activity (G.6) under the Hazardous Activity and Industries List.
- NES for Plantation Forestry 2017 (NES:PF) – where plantation forestry activities form part of a disposal and treatment field; and
- NES for Freshwater 2020 – where a discharge to land is located within the vicinity of wetlands.

## 5.2 Northland Regional Policy Statement and Proposed Northland Regional Plan (PNRP)

Discharges to air, land, and water in the Far North District are provided for by the objectives and policies of the Northland Regional Policy Statement (RPS) and the Northland Regional Plans. A resource consent application seeking to implement a WWDTL scheme will need to demonstrate alignment with these policy documents and require particular attention early in a project to confirm site suitability and viability.

At the time of drafting this document, Northland Regional Council is undertaking a plan change, seeking to update the operative regional plans to align with recent NPS directions and to combine individual plans into a single document. The PNRP is currently subject to appeals, which are in the process of being heard at the Environment Court. As per s86B(3) of the RMA, rules in a proposed regional plan have *immediate legal effect if the rule:*

*(a) protects or relates to water, air, or soil (for soil conservation); or*

*(b) protects areas of significant indigenous vegetation; or*

*(c) protects areas of significant habitats of indigenous fauna; or*

*(d) protects historic heritage; or*

*(e) provides for or relates to aquaculture activities*

In addition to wastewater discharge rules having immediate legal effect, the PNRP has been part way through the appeal stage, with a number of relevant rules having been either no appeals or resolved appeals. Given this, the currently operative regional plans (Northland Regional Water and Soil Plan and the Northland Regional Air Quality Plan) are considered to be superseded and are not considered in this guidance document.

The overarching objectives and policies laid out in the RPS and the PNRP, as they relate to wastewater treatment and discharge, seek to protect the ecological, cultural, and social values of land and water through managing water quality and the effects of discharges to the environment. The PNRP also provides objectives and policies that drive the decision-making process in alignment with the national policy and regulatory framework. All wastewater discharges from a wastewater treatment plant to land or water require resource consent under the PNRP for a discretionary activity in accordance with Rule C.6.2.2 and subject to policies that pertain to ecological and cultural values.

<u>Tāngata whenua values</u>

Any effects on the health and wellbeing of lakes, rivers, and streams, coastal waters, indigenous ecosystems and organisms, and sites and areas of significance to tāngata whenua are identified in the PNRP as issues pertaining to tāngata whenua. As per the policies under D.1 of the PNRP, engagement with tāngata whenua is required to address these issues as part of a resource consent application, in particular:

- Policies D.1.1 – D.1.3, which provide for the requirements of any application to include in its assessment of effects an analysis of effects on tāngata whenua and their taonga, what this analysis must include, and the identification of affected persons for notification purposes.
- Policies D.1.4 – D.1.5 These policies stipulate that activities are generally only granted if adverse effects on the values of Places of Significance to tāngata whenua in coastal and freshwater bodies are avoided, remedied, or mitigated so they are no more than minor. Places of significance are broadly defined in the PNRP

To properly address these policies, it is imperative that the appropriate tāngata whenua are included in the decision-making process at an early stage.

Regionally Significant Infrastructure

Section 5 of the RMA enables communities to provide for their social and economic well-being as well as their health and safety. To recognise the importance that wastewater treatment has in achieving this purpose, Appendix 3 of the PNRP identifies these as 'Regionally Significant Infrastructure' and provides enabling objectives and policies for such infrastructure throughout the plan.

Wastewater treatment plants are listed in Appendix 3 of the PNRP as 'Regionally Significant Infrastructure' and is also subject to enabling policies, including:

- Policies D.2.2, D.2.5, D.2.7, D.2.8, and D.2.11, which provide for the construction, operation, maintenance, repair, upgrade, and protection of regionally significant infrastructure, recognising the positive effects resulting from regionally significant infrastructure and enabling minor adverse effects on the environment where the proposal is consistent with policies protecting tāngata whenua, historic heritage natural character, and indigenous biodiversity values.
- Policy D.2.9, which provides an opportunity to justify the appropriateness of a proposal where adverse effects are greater than envisaged (i.e. more than minor) and the ability for the regulator to give appropriate weight to both the societal need of the proposal and how adverse effects on the environment have been assessed and managed.
- Policy D.2.4, which provides for an 'adaptive management approach' to provide the decision maker with a consent pathway where there is information lacking on the receiving environment and the breadth of potential adverse effects.

Background information and assessments that are used in determining a preferred WWDTL scheme can be included with a resource consent application to demonstrate the social importance of a proposal and provide more information to stakeholders where their input is sought.

Management of Effects on Significant Values

Policies setting the environmental bottom-lines for discharges to land and water are reflected throughout the regional policy framework and driven by the NPS:FM. Key policies in the PNRP relate to the protection of areas with significant or outstanding values and restricting activities that would otherwise degrade these values. Key policies include:

- Policy D.2.16, which seeks to protect historic heritage sites and areas through the avoidance of physical destruction and modification of heritage areas where possible;

- Policy D.2.17, which seeks to manage adverse effects on natural character, outstanding natural landscape, and outstanding natural features, and also strives for the avoidance of adverse effects on these values.

- Policy D.2.18, which seeks to manage adverse effects on indigenous biodiversity, with an emphasis on the avoidance of effects on taxa that are listed as being Threatened or At Risk under the NZ Threat Classification System lists, including plants and animals.

From the outset, site selection should avoid areas with mapped areas of significance to minimise risks to the consenting process and reduce the onerous and costly technical assessments that would be required to support and justify effects on these areas.

## 5.3 Far North District Plan

As noted in 4.6 of this report, a WWDTL Scheme could be authorised under the Far North District Plan through either resource consents (for land use) or by way of a notice of requirement and designation pursuant to ss168A of the RMA. In either case, an assessment of effects on the environment and other supporting technical documentation will be required to support the proposal against the relevant underlying zoning provisions, overlays, and policies.

Given the nature of a WWDTL Scheme, it is envisaged that District Planning requirements will not be an issue for the ongoing maintenance and operation of a scheme, but will be more relevant during the construction of supporting network utilities.

## 5.4 Public and Limited Notification

Where an activity has more than minor effects or is considered to be subject to 'special circumstances', a consenting authority may decide to notify the public and call for submissions on the proposal or identify a group of persons or parties that have more than a general interest in the potential adverse effects of an activity and limit the notification to these parties. Public notification can also be requested by an applicant where it is considered unlikely to resolve all potential adverse effects on certain parties or where positive submissions are expected and can support the decision to grant an application.

While it is ultimately at the discretion of the consenting authority whether to notify or not, the early identification of potentially affected parties and stakeholders by the project team is essential to develop an effective engagement plan to either seek to avoid notification or limit the scope of submissions to particular issues. Unplanned for hearings could push a project programme and budget out beyond what is provided in an approved budget and could delay implementation of scheme by years.

# 6 Cost Estimation

It is good practice to define the expected accuracy or class of cost estimate to align all stakeholders involved in preparing, evaluating and using project cost estimates. By defining the class of estimate, any possible misinterpretation of the quality and value of the information used to prepare the cost estimate as well as the accuracy level expected from estimates and the level of risk associated with estimate is clarified prior to completing the estimate. AACE International in 2005 released Recommended Practice No: 18R-97 “Cost Estimate Classification System – As Applied in Engineering, Procurement and Construction for the Process Industries”. The intent of this guideline is to avoid misinterpretation of the various classes of cost estimates and to avoid their misapplication and/or misrepresentation.

In general terms as outlined in Figure 7, as the project becomes more defined from feasibility through to detailed design, the range of the cost estimate will decrease. At the early project stages significant contingency sums are provided to allow for unknowns during design and construction. As the design progresses these contingency sums reduce but are still required up to and including constructing.

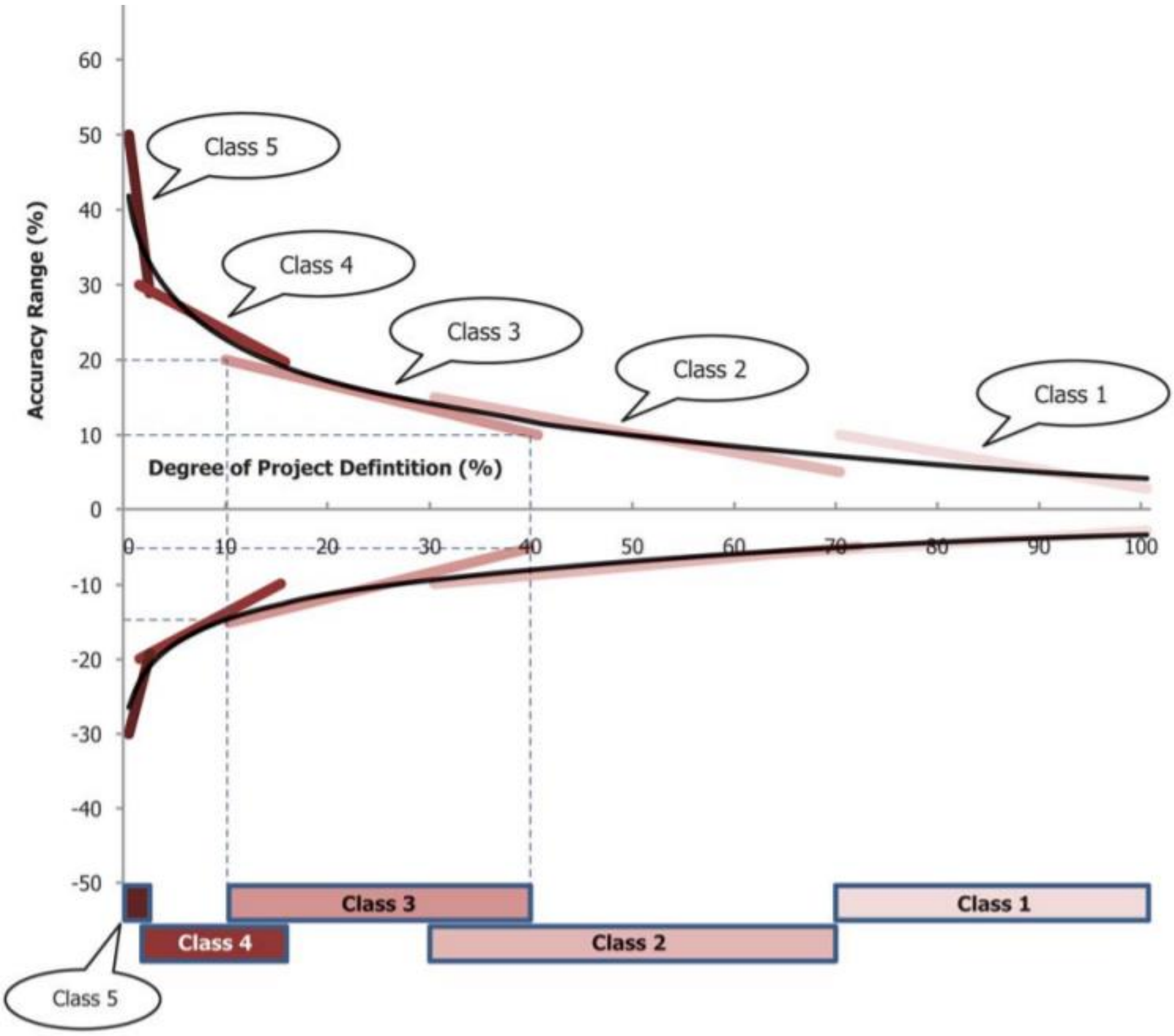



Figure 7 - Cost Estimate Accuracy Range

There are typically five classes of estimates:

> ***Class 5 (Desktop Stage):*** intended level of accuracy ± 50%. Based on limited project scope definition. Generally used to determine indicative end cost values for comparison of scope or delivery

method options and for initial evaluation of project economic viability. Also used for long range planning and project screening.

***Class 4 (Developed Concept Estimate):*** intended level of accuracy ± 25%. Based on preliminary engineered project definition where the driving components of the scope are definable in terms of capacity and quantity. Used to determine indicative end costs for pre-feasibility studies, strategic planning; budget approvals and confirm project economic viability.

***Class 3 (Feasibility Estimate):*** intended level of accuracy ± 15%. Based on a detailed level of project documentation of both scope and project delivery methodology and where meaningful budget quotations of contractor/vendor pricing may be sourced. Represents the minimum standard for client funding requests and bankable feasibility studies.

***Class 2 (Detailed Design Estimate ):*** intended level of accuracy ± 10%. Based on a detailed level of project documentation where the majority of commitments have been formally tendered or already in place. Generally used to determine final cost control baseline, supplier negotiation support, claims and dispute resolution.

***Class 1 (Definitive Estimate):*** intended level of accuracy ± 5%. Based on a highly detailed level of project documentation and the majority of commitments have been formally tendered and or already awarded.

Cost estimates should include:

- Estimate base date – date at which cost and data are based on
- Inclusive/exclusive of escalation – cost difference from estimate base date to time of expenditure (refer below)
- Currency of presentation and exchange rates to be used to convert foreign currencies to that of the presentation currency
- Project delivery methodology – e.g. Design/build or design then construct
- Assumptions and exclusions list – e.g. estimate might exclude Council internal costs
- Consenting costs (including consultation)
- Design, investigation, procurement and construction supervision costs
- Contingency to cover unknowns in design and construction
- Other project constraints – either expressed by the Client or assumed

For WWDTL projects, it is important to get specialist property valuers to provide land cost as this cannot generally be provided by the Engineering team. Rating values are not appropriate to use after the desktop stage (Class 5) estimate. Consent costs can be very difficult to predict (depending on the level of opposition and post-lodgement hearing costs).

# 7 Environmental Investigation Requirements

In the process of discharging treated wastewater to land, it is essential to protect both human and environmental health. Treated wastewater may contain contaminants at concentrations that may cause adverse effects on the receiving environment and human health. In assessing environmental risk of treated wastewater discharge to land, both the initial receiving environment and the final location, known as the environmental endpoint, should be considered. To simplify environmental risk assessment, the endpoints can be grouped into six categories: air, soil, groundwater, surface water, surface water ecology and terrestrial ecology. Unintended environmental effects from discharge of treated wastewater to land can be related to construction of discharge systems and contaminated land.

## 7.1 Air Quality

Potential effects on air quality from land discharge systems relate to odour and aerosols from spray drift. These effects are generally dependent upon the nature of the treated wastewater discharge and whether surface spray or drip-irrigation systems are used.

### 7.1.1 Baseline Investigations

Baseline investigations for air quality include:

- Identification of potential receptors such as residential dwellings
- Characterisation of the treated wastewater quality and potential for odour generation

### 7.1.2 Assessment of Environmental Effects

The following methodologies are generally employed to assess effects:

- Application of appropriate buffer distances from sensitive receptors (e.g. 150m from residential dwellings for surface spray discharge methods)
- Assessment of treated wastewater quality odour generating potential – generally related to the level of treatment received and consideration of pumping distances/potential for septicity
- Air quality effects assessment considering local meteorological conditions, proximity to sensitive receptors and odour generating potential of treated wastewater.

### 7.1.3 Potential Mitigation Methods

Potential methods to mitigate adverse odour/spray drift effects include:

- Use of drip irrigation systems to avoid spray drift
- Use of low pressure surface spray methods to minimise spray drift
- Automated systems to shut-down irrigation of threshold wind speeds
- Application of buffer distances to sensitive receptors
- Higher quality treated wastewater quality to minimise odour generating potential
- O&M manual to include procedures to minimise odour generation and contingency plans.

## 7.2 Soil Quality

Discharge of treated wastewater to land has the potential to degrade the soil structure and therefore leading to a loss of productivity and reduction in soil quality. Soil structure can be damaged by remaining in a saturation condition for a prolonged period. This may occur due to chemical and biological damage by contaminants present in treated wastewater or microbial action in anoxic conditions.

Moreover, organic material, measured as biological oxygen demand (BOD) in treated wastewater may cause anaerobic conditions in the soil. If not managed properly, this could lead to generation of surface bioslimes which may create problems such as soil pore blockage and reduction in soil infiltration capacity, plant die off and odour.

Potential risk of pathogens on soil and plants may occur due entering the food chain by consumption of raw crops. Pathogens can be removed in soil by filtration, adsorption and natural attrition.

### 7.2.1 Baseline Investigations

Baseline investigations for soil quality include:

- Soil sampling to determine soil type, permeability, presence of any limiting drainage layers, chemical makeup and potential to remove contaminants.
- Analysis of the treated wastewater quality and potential for soil contamination.

### 7.2.2 Assessment of Environmental Effects

The following methodologies are generally employed to assess effects:

- Assessment of infiltration capacity of soil and the potential for degradation of soil structure due to high moisture content for a prolonged period.
- Assessment of prolonged soil wetness effects and risks for ponding.
- Assessment of the effects of organic materials in the soil and odour generating potential due to anaerobic conditions.
- Assessment of the level of nutrients and pathogens in soil and their potential losses by overland flow and leaching to ground water.
- Potential effects from trade waste discharges and associated contaminants (e.g. heavy metals or emerging contaminants)

### 7.2.3 Potential Mitigation Methods

Potential methods to mitigate adverse effects include:

- Application of discharge rates in relation to soil moisture and minimising the nutrient leaching to groundwater.
- Halting discharge of treated wastewater when rainfall and/or flooding occurs.
- Maximising retention of nutrients in the unsaturated zone of the soil.
- Use of suitable land discharge systems and applying treated wastewater to all sites to increase the opportunity for filtration and predation of pathogens.
- Treatment of wastewater to a higher quality to mitigate contamination of soil, groundwater and surface water.

## 7.3 Groundwater Quality

In discharge of treated wastewater to land, there is the potential for treated wastewater derived contaminants to leach into groundwater. Due to leaching of contaminants to groundwater, groundwater can contain elevated concentrations of disease-causing microorganisms (pathogens) and chemical contaminants. The groundwater resource can then have potential adverse effects on human health and environment if used as potable water or irrigation or enters surface water. The most severe potential adverse effects of discharge of treated wastewater to land is leaching of nitrate and pathogens into groundwater. The potential risk is higher when groundwater is shallow and attenuation of nitrate and pathogens is reduced. Potential effects can also occur if downstream waters are used for potable or stock water sources.

A big portion of nitrogen from discharge of treated wastewater to land is taken up by plants, intercepted by soil, or volatilised. Application of additional nitrogen from treated wastewater to meet plant requirements may increase the risk of nitrogen transported to groundwater.

Phosphorus from treated wastewater can be avoided entering the groundwater by sorption to soil, incorporation into soil organic matter and plant uptake. Potential adverse effects due to phosphorus when groundwater enters surface water are discussed in Section 7.5.

UV treatment of wastewater reduces pathogen loads to the land. Moreover, remaining pathogens in treated wastewater perish within 10 mm of the soil surface. Adverse effects of pathogen from the discharge of treated wastewater to land may occur when groundwater enters surface water and are discussed in Section 7.5.

### 7.3.1 Baseline Investigations

Baseline investigations for groundwater quality include:

- Identification of groundwater and surface water receptors.
- Using Overseer[7] model to estimate the amount of nutrients leaching to groundwater and subsequent interactions between surface water and groundwater

### 7.3.2 Assessment of Environmental Effects

The following methodologies are generally employed to assess effects:

- Assessment of potential adverse effects on human health and stock due to leaching of pathogens to groundwater.
- Assessment of the potential for discharge of treated wastewater to surface water by groundwater drainage or overland flow and contamination of surface water.

### 7.3.3 Potential Mitigation Methods

Potential methods to mitigate adverse effects include:

- Development and design of a discharge rate to avoid saturation of the soil and minimise loss of nutrients and pathogens directly to groundwater.
- Higher treated wastewater quality to minimise the level of nutrients and pathogens to groundwater and surface water.

## 7.4 Groundwater Flows

The initial environment to receive the discharge of wastewater is the soil and plant system of the land. If the treated wastewater is not retained in the soil, it may travel to groundwater, or by overland flow to local surface water that could cause potential adverse effects.

Organic material (as BOD) in groundwater can cause a problem if the groundwater reaches the surface. High BOD results in a reduction in dissolved oxygen and creates anaerobic conditions. Anaerobic conditions in groundwater may lead to an unpleasant taste or odour, and when groundwater enters surface water may

[7] Noting that the use of Overseer is currently being reviewed by the Ministry for Primary Industries (MPI)

cause mortality of river flora and fauna, and growth of undesirable flora and fauna. However, when the treated wastewater percolates through the soil, BOD is metabolised by the soil bacteria. Therefore, the level of BOD reaching groundwater will be negligible and the adverse effects will be minor.

#### 7.4.1 Baseline Investigations

Baseline investigations for groundwater flows include:

- Testing of the soil properties.
- Investigating the regional hydrogeological setting and nearby water bores
- Evaluation of groundwater flow and level in the site.
- Investigating the pathways of treated wastewater through the surface water.
- Identification of surface water receptors.

#### 7.4.2 Assessment of Environmental Effects

The following methodologies are generally employed to assess effects:

- Assessment of the risk for overland flow and discharge to surface water receptors.
- Assessment of the risk for mounding and ponding considering the discharge rate and groundwater flows.
- Assessment of potential effects on downgradient bore users (both human and stock drinking water)
- Anaerobic conditions assessment in groundwater that may cause unpleasant odour.

#### 7.4.3 Potential Mitigation Methods

Potential methods to mitigate adverse effects include:

- Adopting an appropriate discharge system to avoid exceeding field capacity.
- Adopting an appropriate discharge rate and frequency to avoid preferential or bypass flow through large soil pores, minimise the risk of mounding, and maximises evapotranspirative loss.

### 7.5 Surface Water Quality

The discharge of treated wastewater to land has the potential to have adverse effects on water quality in receiving waterways and the in-stream ecology of this waterway if discharge occurred at rates that allowed for overland runoff into surface water or because of leaching and spray drift onto nearby surface waters. In the discharge of treated wastewater to land, groundwater is expected to be the main source of treated wastewater which enters surface water by indirect run-off.

Potential adverse effects to water quality could be contamination with contaminants that may be present in treated wastewater (i.e., chemicals and pathogens). These contaminants could cause toxicity to humans, wildlife or plant species. Moreover, excess nutrients loading to surface water may have potential adverse effect such as eutrophication due to excess nutrient loading. Leaching and runoff are the main processes by which nutrients (phosphorus and nitrogen) are carried into streams.

Potential positive effects to in-stream water quality could occur when the quality of the treated wastewater is higher than the receiving water. Discharge of high quality treated wastewater would dilute the receiving water and improve water quality.

Discharge of treated wastewater to wetlands or drains leading to wetlands can adversely affect wetlands. If the treated wastewater is high quality, it would benefit wetlands by flow enhancement and water quality improvement. Otherwise, potential adverse effects related to discharge of low quality treated wastewater to wetlands may include eutrophication, presence of contaminants that are harmful to aquatic life (e.g., chemicals, potential pathogens, BOD) and physical properties of the water that may be deleterious to plants and animals (e.g., temperature and rate of flow).

### 7.5.1 Baseline Investigations

Baseline investigations for surface water quality include:

- Identification of potential surface water receiving environment.
- Continuous water quality monitoring in surface waters and identifying the level of contamination due to discharge of treated wastewater.

### 7.5.2 Assessment of Environmental Effects

The following methodologies are generally employed to assess effects:

- Assessment of the environmental risks of treated wastewater discharge to surface water (leading to eutrophication, reduction in dissolved oxygen or change of temperature).
- Assessment the level of contaminants entering the surface water bodies and their potential risk on human health.

### 7.5.3 Potential Mitigation Methods

Potential methods to mitigate adverse effects include:

- Design and use of a suitable land discharge system to mitigate direct run-off of treated wastewater to surface water.
- Application of buffer distances from surface waterbodies (for example, maintenance of 20 m exclusion zones).
- Improving the quality of the treated wastewater to a higher standard and/or wastewater source controls (e.g. trade waste controls)

## 7.6 Surface Water Ecology

As discussed above, treated wastewater discharge to land might enter surface water via either surface run-off or groundwater drainage and affects the ecology of the water body.

Although application of nutrients to the land through treated wastewater is expected to be mostly taken up by the plants, leaching of nutrients may happen and they may enter surface waters from the catchment via groundwater. The presence of nutrients in surface water, such as nitrates and phosphates promote the growth of algae and other plant life, which take oxygen from the water, causing the death of fish. In addition, they might cause alteration of river flow due to blockage by macrophytes, and changes in biodiversity.

Moreover, organic material (as BOD) present in treated wastewater can lead to a decrease in the dissolved oxygen content of the streams. This reduction in dissolved oxygen causes stress on the ecosystem and mortality of river flora and fauna.

### 7.6.1 Baseline Investigations

Baseline investigations for surface water ecology include:

- Investigating aquatic flora and fauna assemblages in surface water.
- Investigating whether there are any rare or endangered species present in the surface water.

- Investigating ecological condition of the surface water to predict any ecological damage arising from the treated wastewater discharge.
- Assessment of baseline hydraulic flow and investigating the alterations in the flow regime due to discharge of the treated wastewater.
- Investigating growth of algae and other plant life due to excess nutrient loading.

### 7.6.2 Assessment of Environmental Effects

The following methodologies are generally employed to assess effects:

- Assessment of the toxic effects of contaminants entering the surface water on ecology.
- Assessment the effect of reduction in dissolved oxygen on flora and fauna.
- Assessment of the effects on flora and fauna due to flow changes.
- Assessment of nutrient effects on algae growth and excessive growth of nuisance aquatic plants.

### 7.6.3 Potential Mitigation Methods

Potential methods to mitigate adverse effects include:

- Mitigating direct run-off of treated wastewater from land to surface water.
- Improved treatment at wastewater treatment plants and discharge to water bodies.
- Undertaking ongoing monitoring to ensure eco-toxicity thresholds are not exceeded and native freshwater flora and fauna are not affected.
- Inclusion of a setback from surface water bodies to minimise the risk of adverse ecological effects.

## 7.7 Terrestrial Ecology

Potential adverse effects on terrestrial ecology from discharge of treated wastewater is associated with alterations to soil nutrients, soil moisture and presence of other contaminants in soil. The level of the effects is generally dependent on characterisation of the treated wastewater and sensitivity of terrestrial flora.

### 7.7.1 Baseline Investigations

Baseline investigations for terrestrial ecology include:

- Characterisation of the treated wastewater quality.
- Investigating and identifying sensitive and vulnerable vegetation on land.
- Investigating the effects of discharge on land vegetation due to changes in soil nutrients, soil moisture, and increases in organic matter.

### 7.7.2 Assessment of Environmental Effects

The following methodologies are generally employed to assess effects:

- Assessment of the effects of treated wastewater discharge on plants growth and die off.
- Assessment of the effects of nutrients on plant damage.

### 7.7.3 Potential Mitigation Methods

Potential methods to mitigate adverse effects include:

- Higher quality treated wastewater to mitigated adverse effects on plants.

- Application of buffer distances from sensitive vegetation.
- Cessation of the discharge of treated wastewater to area with sensitive and vulnerable flora.

## 7.8 Contaminated Land

A series of contaminated land management guidelines has been developed by Ministry for the Environment (MfE) to assess and manage contaminated land throughout the country[8] (Ministry for the Environment, 2012).

A land is considered contaminated when it has been affected by a hazardous contaminant. Different types of contaminants can be present in leachate and/or runoff from contaminated sites which have been affected by contaminated water or soil, mainly from historical industrial and rural land use activities.

The National Environmental Standard (NES) for the Protection of Human Health from Contaminants in Soil manages the risk of adverse human health effects from contaminants in land. The Hazardous Activities and Industries List (HAIL) is used for consistently reporting on site history and for identifying sites for inclusion on local government land-use registers. 'Waste disposal to land' is listed as activity G5 on the HAIL. Sites receiving treated wastewater will becomes listed on the HAIL and the NES may apply for any future land use activities.

This differs from the actual potential for wastewater derived contaminants to accumulate within soils. Modern land treatment systems should be designed and managed to avoid the significant accumulation of contaminants such as heavy metals.

However, the potential for contaminants to accumulate within the soil is matter which should be assessed as part of environmental investigations informing the concept design.

## 7.9 Construction Effects

The physical construction of a WWDTL system may cause a range of effects related to earthworks, vegetation clearance, temporary occupation of construction laydown areas, and the physical installation of pipeline and irrigation infrastructure. Noise and traffic effects can also be generated through construction. These effects are considered through the resource consents or Notice of Requirement (NoR) process for a designation.

## 7.10 Environmental Benefits of Treated Wastewater Discharge to Land

There are a number of benefits associated with the irrigation of land with treated wastewater. These advantages may include:

- Providing essential nutrients and organic matter for plant growth,
- Reducing contamination of waterbodies.
- Increased water availability for irrigation.

As discussed, quantities of macronutrients (nitrogen and phosphorus) are supplied to soil and plants by disposal of treated wastewater to lands that can positively affect plant growth. Discharge of treated wastewater to land can also provide other positive environmental impacts as they contribute to protect quality of the receiving waterbodies (sea, rivers and lakes) by diverting treated wastewater from their existing discharge receiving environment. Additionally, beneficial impacts to receiving water bodies may occur when the treated wastewater is of better quality than receiving waters. Using treated wastewater as an irrigation

[8] Ministry for the Environment, 2012. Users' Guide: National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (Report). Ministry for the Environment, Wellington.

source after appropriate treatment has environmental benefits since it could conserve a huge quantity of freshwater.

# 8 Tāngata Whenua and Stakeholder Engagement

Tāngata whenua and stakeholder engagement is a key principle to get right in every WWDTL scheme. The following section provides a high-level overview of key considerations.

## 8.1 Landowner Investigations

Private landowner investigations need to be handled with sensitivity. It is preferable to engage a property consultant (unless Council has an internal property expert) to engage with private land-owners who may be willing to either sell or lease their land. This is recommended as the process of acquiring land is a relatively specialised process.

Some owners may wish to receive the irrigation benefits of treated wastewater.

## 8.2 Tāngata Whenua Engagement

Tāngata whenua should be engaged from the start of a WWDTL project along with other key stakeholders. Whilst a successful WWTDL project would divert treated wastewater away from surface water receiving environments, potential effects on sites of cultural significance from the process of discharging wastewater to land could result depending on location and methodology.  Additional cultural associations with whenua that are not public knowledge or recorded in accessible databases need to be understood through engagement with the appropriate tāngata whenua.

There is no one size fits all approach for tāngata whenua and stakeholder engagement. It is recommended however that engagement starts early, an engagement plan is developed that becomes a living document throughout the project and a comprehensive audit trail is maintained throughout the process to record key engagement activities and outputs.

## 8.3 FNDC Internal Stakeholder Engagement

It is important to consider internal stakeholders alongside external parties. It is particularly important that operators of the future WWTDL system are involved in the design to ensure they have inputs to the design process through concept and detailed design.

# 9 Case Studies

## 9.1 Whangamata

Thames-Coromandel District Council (TCDC) collects and treats wastewater from the Thames urban area, as well as several small (mostly beachside) communities in the district. This includes the Whangamata beach community. The Whangamata WWTP is currently a Sequential Batch Reactor (SBR) system as per its most recent upgrade, and serves a population of 4,074 (2018) which swells to over 25,000 over the Summer period.

The Whangamata WWTP disposes of its wastewater via irrigation to the nearby Tairua forest above the WWTP and has done since 1986. The irrigation scheme consists of three distinct zones (Figure 8) totalling 40 ha. Zone 1 has been utilised for effluent disposal since land disposal at Whangamata started in 1986. The irrigation scheme was expanded to include Zone 2 in 1990. Zone 3 was designed and commissioned following the variation of the discharge consent conditions in 2001.

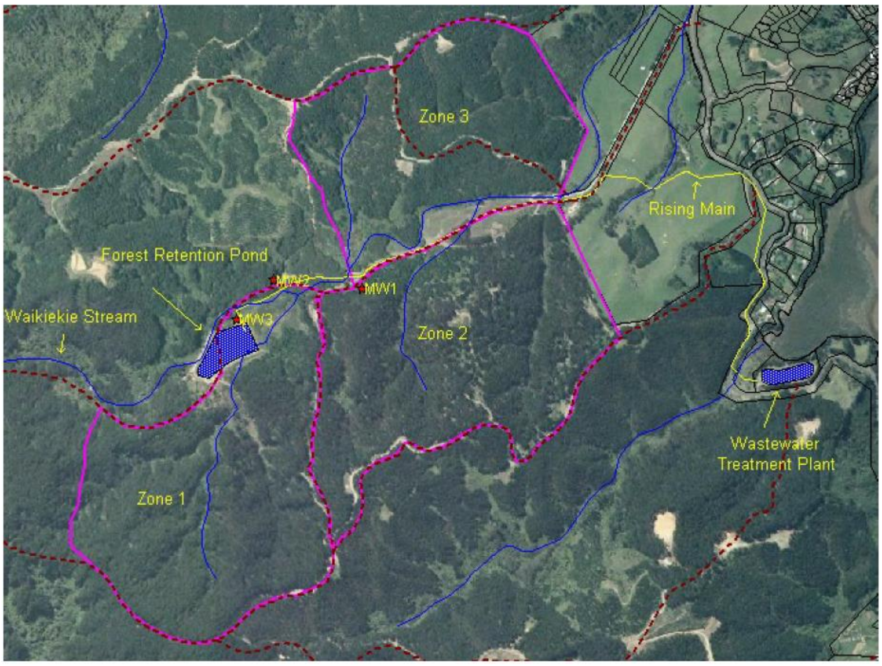



Figure 8 - Overview of Whangamata WWTP and forest irrigation scheme (Whangamata Environment Court, Colliar, 2007)

Treated effluent is pumped approximately 3 km from the WWTP via a 250mm diameter rising main to the forest retention pond (56,000m$^3$). The rising main discharges into the retention pond via a UV disinfection system.

Treated effluent is currently irrigated to 40 hectares of commercially operated plantation pine areas in the Tairua Forest via a network of irrigation mains, sub-mains, laterals, pumps, valves and sprinklers. There are separate distribution mains to each Zone, and three separate irrigation pumps deliver the treated wastewater to the irrigation blocks in each Zone.

The irrigation system comprises a network of about 400 full rotation sprinklers and about 30 half rotation sprinklers within Zones 1 and 2, and about 340 full rotation sprinklers and about 40 half rotation sprinklers within Zone 3. The sprinklers are permanently installed plastic impact sprinklers mounted on steel standards about 1.2m high. Part sector sprinklers are used to allow precise control of the extent of irrigation.

A typical sprinkler in operation and a sprinkler in operation in Zone 1 are shown in Figure 9.

Figure 9 - Existing Whangamata wastewater system irrigation sprinklers

A number of investigations of the Whangamata wastewater irrigation system were undertaken by Forest Research Institute (FRI) between 1986 and 1998. In 1993, monitoring results from 1986 to 1993 were reported and in 1998 monitoring results from 1997 were reported building on earlier FRI findings. Forest Research estimated that effluent loading rates used at Whangamata from 1986-1990 were approximately 50mm/week during both summer and winter. Annual nitrogen loading rates were estimated to be some 1,658kgN/ha/yr.

Symptoms of poor tree health were first identified in February 1989. Two surveys of tree health within the irrigated blocks were performed during 1989 and 1991. The results of the 1989 survey showed that approx. 1.5% and 6% of the irrigated crop had died or were suffering crown die-back, respectively, compared to a total of 2% of the trees showing either of the ill health symptoms in control areas. The crown die-back and tree mortality observed in 1989 were believed to be due to high soil moisture contents caused by the high effluent loading prior to 1991.

Following the scheme's first expansion to include Zone 2, in 1990, it was estimated that hydraulic loading rates were 30mm/week and nitrogen loading rates were estimated to be some 1,162kgN/ha/yr. However, in 2001, it was discovered that the irrigation areas used prior to the system expansion to include Zone 3, were significantly smaller (estimated in 1998 to be 40ha, but actually 27ha) than originally thought, and as a consequence, the nutrient and hydraulic loading rates calculated in earlier years were somewhat less than those actually being applied.

The results of the 1991 survey showed that the total number of trees exhibiting ill health had not increased since the earlier survey. Tree growth monitoring indicated that tree height was slightly higher in irrigated areas up to 1992, but measurements in 1997 indicated that the tree heights in irrigated areas were similar to control areas.

The 1998 report commented that the reduced irrigation rates since 1991 were positive for the overall performance of the land treatment scheme. In Zone 2, tree diameters were higher for the irrigated trees while tree heights showed no distinct differences. The impact on the wood density in irrigated areas of Zone 1 was also compared to that found in control areas. This work built on previous findings in 1993.

In 2006, soil chemistry in irrigated plots of zones 1, 2 and 3 were sampled and analysed by Landcare Research after the resource consent application was lodged in June 2006, with the results indicating elevated levels of several contaminants within the irrigated soil. Similarly, monitoring wells showed elevated levels of microbes and ammonia leading into groundwater, particularly between the forest retention pond and Waikiekie stream. It was noted that at times, the irrigation had impacts on the level of nitrogen and bacteria in the Waikiekie stream and subsequently, the Whangamata Harbour – however, not as the primary contributor of such contaminants, as the 2001 Regional Council report suggested.

## 9.2 Raglan

### 9.2.1 Key Aspects

Raglan is located on the west coast of the Waikato Region and has the following characteristics:

| | |
|---|---|
| Population size | 4,850 (2020) |
| Projected population | 8,820 (2055) |
| Average daily wastewater flow ($m^3$/day) | 1,165 (2020) |
| Average daily wastewater flow ($m^3$/day) | 1,960 (2055) |
| Existing WWTP process | Oxidation ponds + Aquamats + UV disinfection |
| Current discharge location: | Raglan Harbour (outgoing tide discharge) |
| Proposed discharge: | Discharge to land (optioneering still being undertaken) |

### 9.2.2 Introduction

The Raglan WWTP was constructed in 1976 and originally consisted of two oxidation ponds which discharged into the harbour mouth. The current WWTP, which was last upgraded in 2007, includes anaerobic ponds, aerobic ponds (Aquamats), storage ponds and UV disinfection. The treated wastewater discharge continues at the harbour mouth on the outgoing tide.

### 9.2.3 Historic Discharge to Land Investigations

The discharge to the Whāingaroa Harbour has been offensive to hapū since the Raglan County Council (now Waikato District Council) did not adhere to the original Water Right conditions and ignored advise from local Maori people regarding the siting of the oxidation ponds in the vicinity of Te Rua o Te Ata (Taniwha of Tainui), when the ponds were originally constructed in 1976/77.

Tāngata whenua views expressed historically regarding the treated wastewater discharge have been constant, which at a high level can be summarised as:

- Discharging human waste into the sea is abhorrent and in conflict with Maori values
- There are more suitable options available for disposing of sewage in Raglan than into the ocean

The area surrounding Raglan has generally steeper topography and soils are dominated by clays in close proximity to the existing WWTP site. Thus, whilst historic investigations have determined that the discharge of treated wastewater to land is practicable, the cost has been determined to be prohibitive.

Tainui have appealed the consent decisions from the Waikato Regional – in the early 1990s (to the Planning Tribunal) and in 1997/98 to the Environment Court, which sought to upgrade the WWTP to a higher level of treatment but continue the discharge into the Whāingaroa Harbour mouth. The existing resource consent was granted through an Environment Court decision in 2005, where Tainui was the key appellant.

### 9.2.4 Recent Discharge to Land Investigations

In 2017, Waikato District Council commenced investigations to determine potential areas of land that could be suitable for the discharge of treated wastewater. These investigations continued though to 2019, focussing on potential areas of land within 10km of the WWTP.

Four potential land treatment options have been investigated, including deficit and non-deficit irrigation, with and without alternative winter marine disposal options (dual discharge). Based on these four options the following irrigation areas and storage volumes were deemed to be required:

1. Non-deficit, all year round: 90 – 190 ha, 150,000 cubic metres of storage

2. Non deficit, dual discharge: 80 ha – 110 ha, 20,000 cubic metres of storage

3. Deficit, all year round: 260 ha – 570 ha, 300,000 to 400,000 cubic metres of storage

4. Deficit, dual discharge: 220 ha – 240 ha, 20,000 cubic metres of storage

Over 40 landowners were contacted with no landowners expressing interest in either selling their land for use a treated wastewater discharge site or for lease arrangements. These 40 land treatment properties are shown in Figure 10.

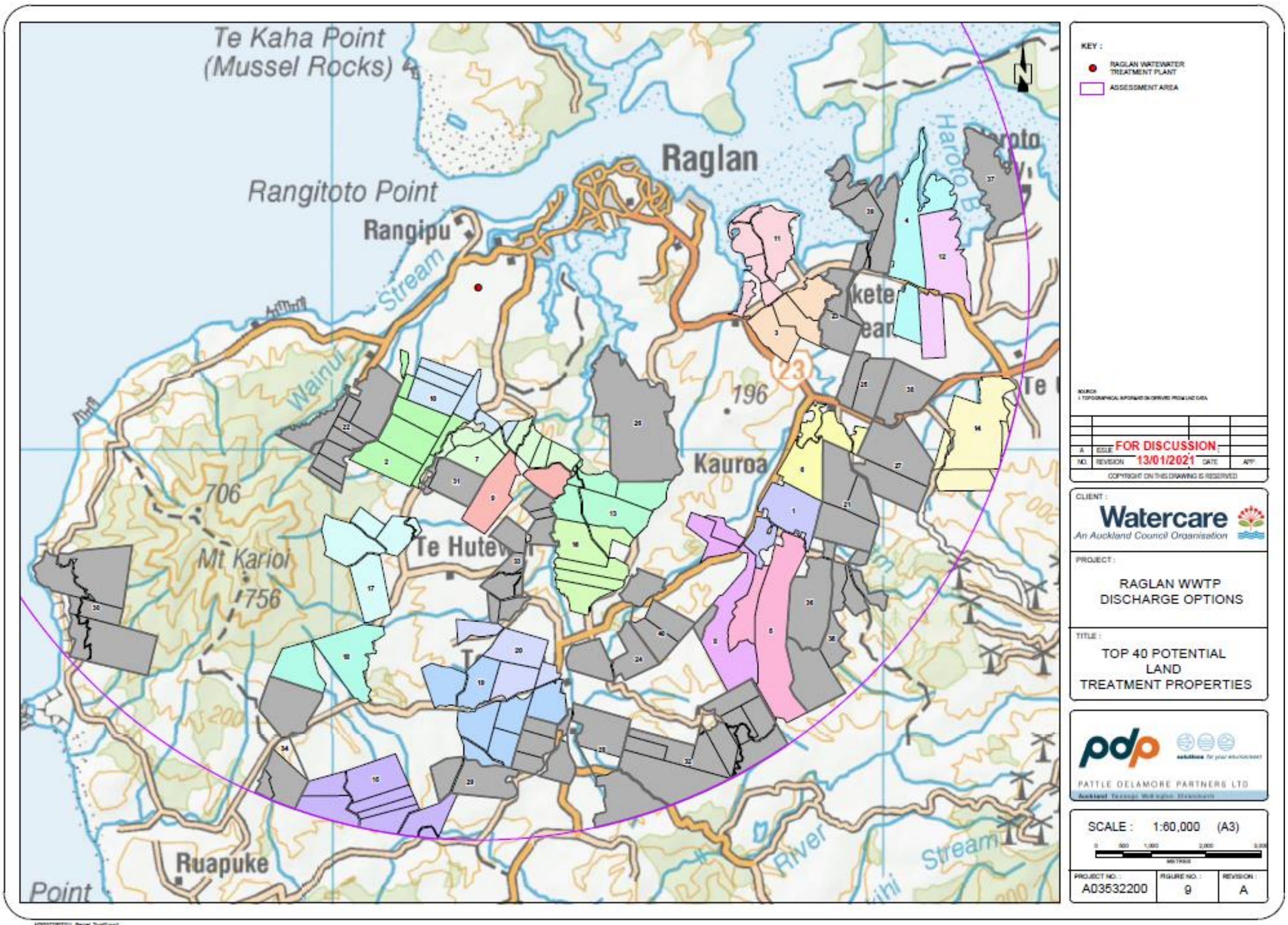



Figure 10 – Top 40 Potential Land Treatment Properties Assessed[9]

### 9.2.5 Tāngata Whenua and Stakeholder Engagement

The Raglan WWTP has a complex and controversial history.

Since 1994, during two consent processes, two community stakeholder groups were formed to develop a community led wastewater solution. These worked between 1996/97 and 2001/01, neither which managed to agree on a preferred discharge solution suitable to all.

Since 2019, Waikato District Council and Watercare Waikato have embarked on a renewed hapū and stakeholder engagement process, which has revolved around in-person hui with hapū and the formation of a key stakeholder group, which has met in person and on-line since May 2019. Further details can be found on the dedicated website here:

[9] PDP, 2021. Raglan Wastewater Treatment Plant Discharge Options – Assessment of Land Irrigation.

https://www.waikatodistrict.govt.nz/services-facilities/water/wastewater/raglan-wastewater-discharge-consent

#### 9.2.6 Current Stage of the Project

At the current stage of the project (September 2021) investigations are continuing into land discharge options for publicly available land, including Council Reserve land. It is hoped that a resource consent application for a long-term solution can be lodged with the Waikato Regional Council by mid-2022.

## 9.3 Central Hawkes Bay – Te Paerahi and Porangahau

### 9.3.1 Key Aspects

Te Paerahi and Porangahau are located on the East Coast of the Central Hawke's Bay District and have the following characteristics:

*Te Paerahi and Porangahau*

| | |
|---|---|
| Population size | Approx. 200 |
| Average daily wastewater flow ($m^3$/day) | 90 (Te Paerahi) and 130 (Porangahau) |
| Existing WWTP process | Oxidation pond |
| Future WWTP process | Oxidation pond + UV disinfection |
| Current discharge location: | Discharge to sand dunes (Te Paerahi) and Porangahau River (Porangahau) |
| Proposed discharge: | Transition to discharge to land within 9 years. Pastoral grazing with low intensity rotational cropping. |

### 9.3.2 The Big Wastewater Story

The Big Wastewater Story is Central Hawke's Bay District Council's (CHBDC) major infrastructure project to secure the future of the district's wastewater network. This involves the following wastewater projects:

1. Project one – Waipawa, Waipukurau and Otane;
2. Project two – Porangahau and Te Paerahi
3. Project three – Takapau

Further details can be found here:

https://www.chbdc.govt.nz/our-district/projects/the-big-wastewater-story/

### 9.3.3 Te Paerahi and Porangahau

The existing WWTP for Te Paerahi, although discharging to land, is located within a sensitive cultural site. The existing Porangahau WWTP discharges directly to the Porangahau River. Both discharges are culturally offensive and the local community has been wanting the discharges moved onto land for some time.

Since 2018, CHBDC has been consulting with the community and mana whenua on a preferred discharge solution. This has culminated in a staged plan to remove the existing discharges from the present locations and to discharge 100% of future flows to private land. Further details are shown on the diagram below.


Figure 11 – Proposed Future Wastewater Network[10]

As of September 2021, long-term consent applications for the discharge of treated wastewater to land have been lodged with the Hawkes Bay Regional Council and are being processed. The various technical investigations accompanying the application along with a consent summary can be found here:

https://www.chbdc.govt.nz/our-district/projects/the-big-wastewater-story/porangahau-and-te-paerahi-wastewater-system-upgrades/

### 9.3.4 Demand for Irrigation Water

Given the severe droughts in recent summers the Central Hawkes Bay District has suffered from severe water shortages in recent times. This has driven a strong demand for irrigation water. Consequently, there is a willingness from private land owners to investigate the option of discharging treated wastewater to land for irrigation and nutrient benefit.

### 9.3.5 End Use and Land Acquisition

The current land of the farm where treated wastewater will be applied is pastoral grazing (sheep and beef finishing) with low intensity rotational cropping (chicory, turnips, oats for stock feed). The land will remain in private ownership and CHBDC has applied for consent to discharge to that private land. Access to the land is being made through a private access agreement.

[10] PROJECT 2 | Porangahau and Te Paerahi Wastewater System Upgrades | Central Hawke's Bay District Council (chbdc.govt.nz)