Technical Advice on Wastewater Performance Standards

Rapid Infiltration Systems (RIS)

Taumata Arowai

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1. Introduction

The recent Priority Item reporting supersedes some of the information in this report. Therefore, this report must be read in conjunction with the Discharge to Land Priority Item reporting (Appendix A). Where information has been superseded it has been struck out.

1.1 Background

The Water Services Authority – Taumata Arowai (herein referred to as Taumata Arowai), under its statutory authority conferred by the Water Services Act 2021, has been developing national wastewater treatment Standards that will apply to new or renewed resource consents for publicly operated wastewater treatment plants (WWTPs).

The initial tranche of National Wastewater Environmental Performance Standards were released for public consultation in March 2025. This included proposed numeric limits for treated wastewater quality in discharges to land (via slow rate application methods) and to water (including fresh and marine waters), as well as Standards for the beneficial use of biosolids and for monitoring and reporting on wastewater network overflows.

The discharge to land Standards identified Rapid Infiltration Systems (RIS) as a relatively low-cost and more ‘compact’ solution for land application that is widely implemented throughout New Zealand. However, due to the fundamental differences in design and operation (for RIS) compared with slow rate irrigation systems, it was necessary to develop the RIS Standards separately.

This current scope of work has been undertaken to address the use of RIS in New Zealand, by providing a supporting RIS Standard as an addendum to the Discharge to Land Standard completed in March 2025.

1.2 Purpose of this report

The purpose of this report is to:

– Provide technical advice to support the further development of National Wastewater Environmental Performance Standards for discharges to land, which currently addresses discharge to land by slow rate discharge. This report is intended to be an addendum to the recently prepared discharge to land Standard to capture Rapid Infiltration Systems (RIS), termed the RIS Standard herein.
– Provide information that Taumata Arowai can use for engagement with stakeholders relevant to the development of the RIS Standards, where required.

1.3 Limitations

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Qualifications and Exclusions

In addition to the above, this report **excludes** the following aspects:

- The level of detail provided in deliverables will be sufficient to inform an Order of Council and summarise rationale for conclusions reached. It excludes the preparation of detailed guidance to support the practical implementation of the RIS Standards.
- Information provided on the design, operational management and operational control requirements of RIS in this report are limited to high-level information required to guide the development of numerical limits and the risk-based framework which form part of the RIS Standards.
- Iwi perspectives are to be addressed separately by Taumata Arowai.
- Advice on implementation of the RIS Standard and interaction with other legislative requirements is not provided. This report does not consider the existing and potential future legislative frameworks and implications of these proposed Standards on new and existing regulation of consenting processes for WWTPs. Within the scope of this work, the technical advice provided has taken into consideration a review of existing consents for logic testing and benchmarking.
- The information contained in a national database of wastewater consents, developed by Taumata Arowai, reflects the number, location, type and discharge point of publicly operated wastewater treatment plants in New Zealand. This database has been updated with the best available information, by Taumata Arowai, as part of this work to inform the recommendations provided within this report. However, it requires verification and validation as some information is known to be inaccurate. Information, values and analysis contained in this report which has leveraged the database is therefore subject to change following verification and validation of the database.
- The Standards are not designed to be applied to situations where a discharge may occur as a contingency bypass to the main consented discharge (in alignment with the Discharge to Water Standards).

1.4 Assumptions

The following general assumptions have been made in developing the proposed RIS Standard outlined in this report:

- The intent of the Standard is to protect against a variety of potential effects in the receiving environment; to adequately protect public health and to enable the maintenance or improvement of aquatic receiving environment condition where applicable. It is intended to enable discharge to land as a viable, pragmatic and attractive option that manages the risk of adverse effects on receptors.
- The proposed Standard will not directly address potential effects beyond those parameters presented in the numerical limits. However, compliance with the proposed Standard will reduce the risks of other related effects as a result of co-regulation of the relevant contaminants along with those for which Standards have been defined[1].
- The proposed Standard will apply to WWTPs of all sizes but will be limited in scope based on the definition of RIS provided for in this report.

[1] This means reduction in other contaminants as a consequence of reduction of parameters covered under the proposed Standard. Effects of contaminants beyond this will need to be assessed as part of the consenting process

– All RIS covered by the Standard typically accept predominantly domestic wastewater, which has received secondary treatment at minimum which has been interpreted to include the use of waste stabilisation ponds.
– For the purposes of developing the RIS Standard, we have assumed that the RIS is appropriately designed, operated and maintained by a suitably qualified practitioner.
– The RIS Standard is intended to be applied in situations where the land is used as part of the treatment process (and/or where treated wastewater is applied above the groundwater table via wells / bores or chambers), and to be consistent with the approach for other established Standards applicable to land application systems and already implemented in New Zealand. The loading rates proposed as Standards account for the total load to a site, including from the discharge itself, the land on which it is applied and how it is managed (e.g. pasture / cut and carry; seasonal fertiliser application).
– Under current RMA requirements, consent renewals are considered "de novo" which means that the application for a renewal is considered as if it is a new consent application, and it has been assumed that this practice will continue. The assessments undertaken in this report have assumed that any consents issued for treated wastewater discharges will include treatment requirements or other conditions set out in the wastewater standards.
– It is assumed that sites directly used for livestock grazing and the growth of crops for human consumption are not suitable for RIS.

More detailed assumptions related to specific tasks outlined in the agreed scope are provided in the relevant sections of this report.

2. Basis for the RIS Standard

2.1 Overall Approach

In general, the same assumptions and overall approach applied in the development of proposed Standards for discharges of treated wastewater to land and water have been retained for the RIS Standards. For details regarding those assumptions, please refer to the technical reports prepared for Taumata Arowai and released in April 2025, refer to Section 1.4 above.

In summary, this work has applied the following:

– A precautionary approach, recognising that, instead of treatment limits being set on a wastewater treatment plant (WWTP) site-specific basis as is currently the case, treatment limits for some parameters will be set for multiple WWTPs that have the same/similar level of risk (of effects on the receiving environment and sensitive receptors) and site capability. The precautionary approach is applied “overall” and is not intended to achieve the most precautionary outcome for every factor and situation.
– Focus on a small number of key parameters that reflect the majority of the potential for adverse effects in the receiving environment and to public health in relation to wastewater discharges.
– Maintain general consistency of approach between Standards.
– Numeric limits have been developed with reference to relevant existing guidelines and limits commonly used in New Zealand as a preference, however, international sources have been heavily relied upon for this work due to the paucity of New Zealand-based literature specifically relevant to RIS.
– Minimising the need for exclusions to the standards by attempting to incorporate as many geographic settings and operational contexts as possible.

2.2 Definition of Rapid Infiltration Systems (RIS)

The following definition of Rapid Infiltration Systems (RIS) was developed for application in the RIS Standard.

A RIS is a land treatment system for municipal wastewater discharge at relatively high application rates to relatively coarse soil, onto or into land and above the water table. The level of treatment will depend on the site conditions and discharge method.

Table 2.1 RIS definition, methods and key assumptions

Definition	Discharge method examples	Key assumptions
Land treatment systems which discharge on or into land where the Annual Hydraulic Load exceeds 6 m per year	RIS systems include a vast array of discharge methods and terminology. Examples include: Land discharge to ground via excavated or bunded trenches, basins and beds or a closely spaced subsurface pipe network that achieves spatial spread of the discharge. Soakage pits, horizontal or vertical perforated piped systems (including wells) that discharge above the water table. Relevant terms and typologies provided in Appendix B. Examples from the New Zealand consent review in Section 3.2.3.	All treated wastewater is contained within the designated discharge area and infiltrates through the soil, resulting in no runoff or direct discharges to surface water bodies. Standing treated wastewater above the infiltration surface is acceptable within the designated discharge area. No direct discharge to groundwater.
Notes The RIS Annual Hydraulic load varies significantly. The typical range for New Zealand sites and based on the literature is 6 m to 150 m per year. RIS sites with an Annual Hydraulic loading rate greater than 30 m per year will typically occur in coarser soils and have a lower level of soil treatment.		

2.2.1 Exclusions from the definition of RIS

Note that the information presented in this section (Section 2.2.1) has been superseded by Section 9.2 of the DtL Priority Items report provided in Appendix A.

~~A RIS, as defined in the proposed RIS Standard, excludes:~~

- ~~Slow rate discharge to land (5 mm/hr or 15 mm/event or less; refer to the Discharge to Land Standard for Slow Rate Application).~~
- ~~Any direct discharges into groundwater – refer to the Discharge to Water Standard~~
- ~~Any periodic bypass discharges.~~
- ~~Land treatment to a quality for wastewater reuse.~~
- ~~Discharges for Managed Aquifer Recharge (MAR) which have different primary objectives, generally related to enhanced groundwater storage, water quality improvements and water management which are not objectives of the RIS.~~
- ~~Discharges to wetlands.~~

2.2.2 Supporting information

A RIS is a land-based wastewater discharge mechanism that leverages the natural filtering capacity of the soil as a mechanism of wastewater treatment. As wastewater is discharged to the RIS, it percolates through the porous matrix to which it is applied and undergoes a series of treatment processes. These treatment processes include physical straining and filtration, dispersion, chemical precipitation, ion exchange, sorption, and biological mechanisms such as oxidation, reduction and immobilisation (uptake by soil biota). Organic constituents can also contribute to the stable organic matter of the soil (humus). The interactions between the RIS and the underlying land and groundwater system are conceptualised in Figure 2.1.

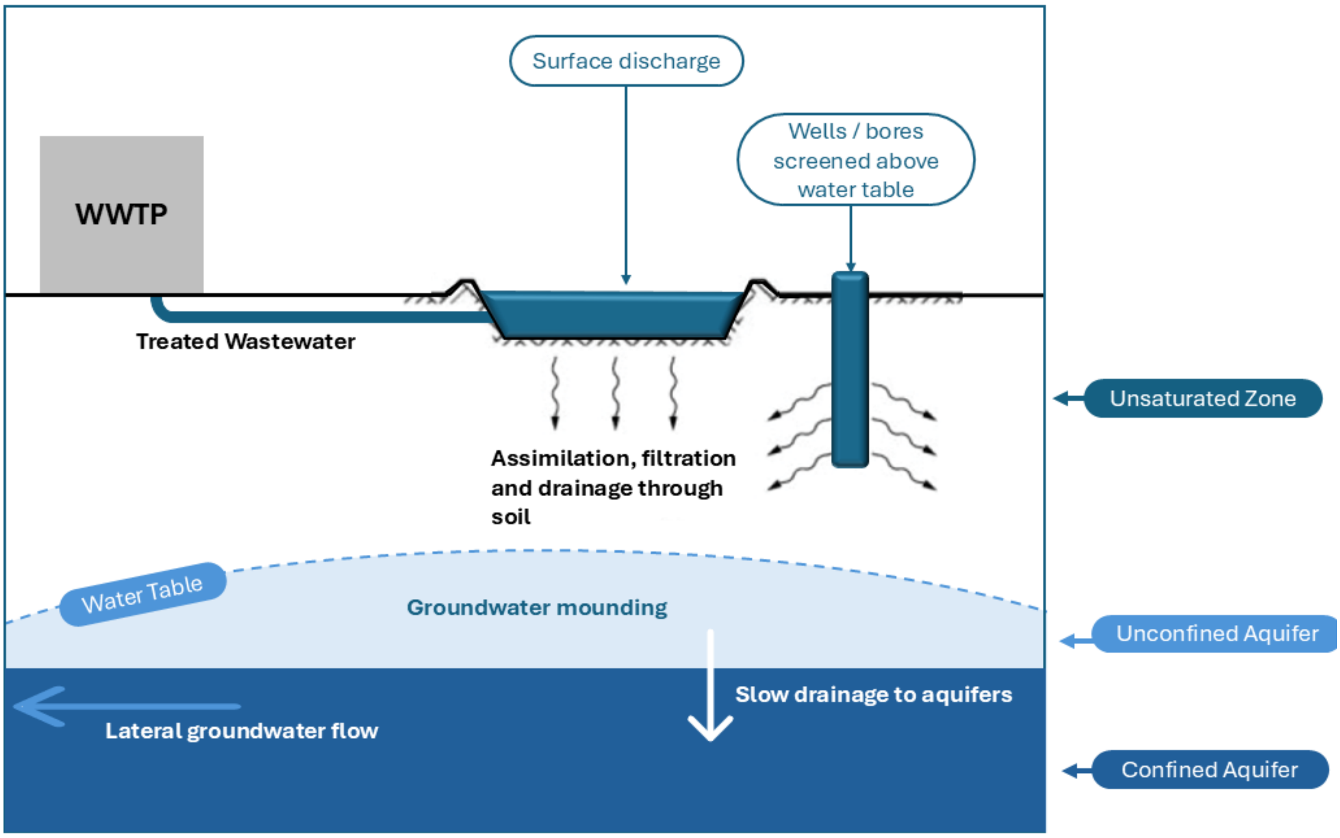

Figure 2.1 Conceptual diagram representing discharges to land by RIS

In the international literature there are examples of systems where the treated wastewater may be collected for further processing or, depending on its quality and local regulations, allowed to discharge into surface water bodies or groundwater aquifers.

The above, general description of a RIS is broad and in the past this lack of clarity has caused challenges in New Zealand for evaluating the suitability of proposed RIS-based schemes and consistent consenting practices. This inconsistency of terminology is further illustrated by the number of different terms used in the New Zealand consents reviewed to support the development of the RIS Standards (refer to Section 3.2.3).

A suitable and clear definition of a RIS that provides appropriate evidence and risk-based boundaries under which consents can be assessed and approved is important for successful implementation.

The literature review detailed below (Section 3) identified several different definitions for RIS. The range of international definitions has been used as the basis for developing a clear definition for the RIS Standard. These are defined in Figure 2.2 below and are formally defined in Table 2.1 (part of the RIS definition presented above). The figure also illustrates the relationship between the two RIS categories and Slow Rate systems in terms of wastewater discharge rate and soil permeability.

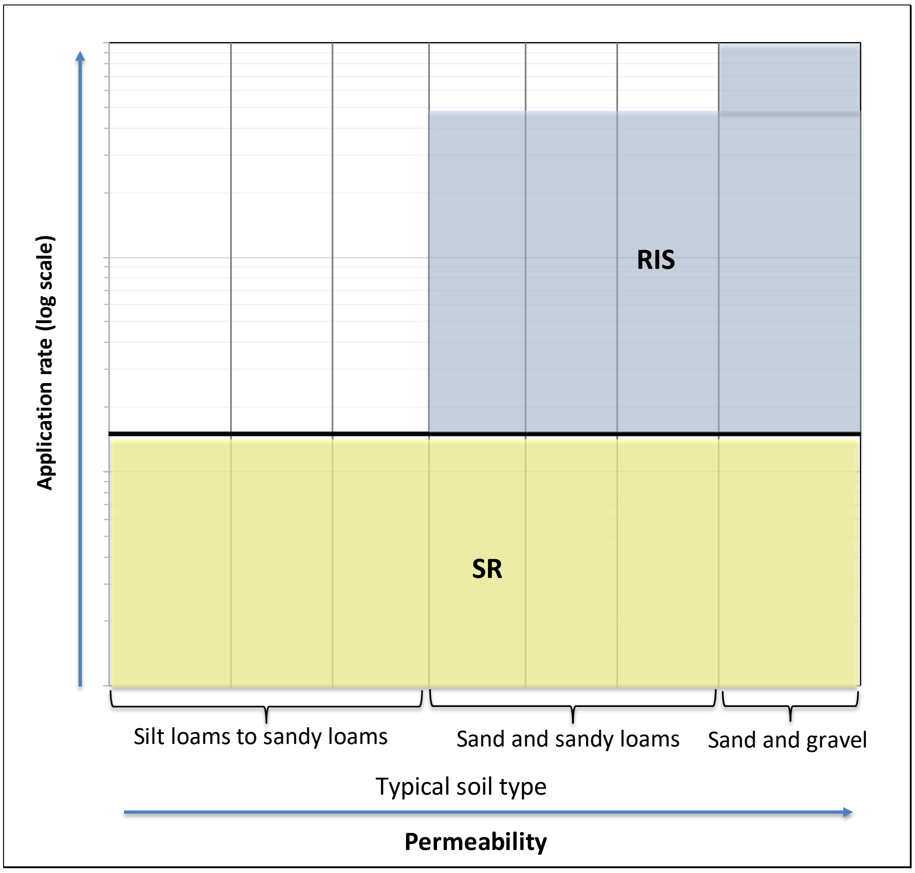

Figure 2.2 Conceptual relationship between Slow Rate (SR) and Rapid Infiltration (RI) and their general relationship to soil type and permeability

Figure 2.2 is based upon (USEPA, 2006) and (Foster, et al., 1994) and shows the relationship between application rate and soils. While the figure is not to scale, the Application Rate scale is logarithmic. The differences in application rate between the categories (as orders of magnitude (factors of ten) were considered in the framework definition developed (as per Table 2.1). In addition to soil, other factors like groundwater mounding can also influence the type of system type that can be utilised at a given site.

SR involves relatively low application rates over a substantial area and is suitable for a wide range of soil types/permeability. SR further treats the treated wastewater applied to a high standard, managed by dose and frequency, but requires a larger land area (Banasiak, et al., 2023). RI involves much higher application rates to smaller areas of land with dose loading to achieve treatment through sub soil in 'pulses', which may result in short term saturation. RI is suited to relatively coarse soil types with good permeability.

The permeability of the entire unsaturated zone is important for RI systems, not just the permeability of the topsoil or shallow soil profile. This is reflected in Table 2.2 in terms of the need to apply these technologies to sites that are free from drainage impediments below the point of application. Examples of drainage impediments in New Zealand include clay horizons in the subsoil and iron pans in the subsoil of some coastal sands. They can also result from the process of soil formation, such as the historic deposition of silt and clay layers in a soil formed by river deposits (known as an alluvial soil). The spatial heterogeneity of soil permeability is also acknowledged, and this needs to be taken into account for site characterisation and system design.

Table 2.2 summarises the characteristics of SR and RI systems. Since the Annual Hydraulic load for RI systems vary widely, the characteristics for a high and very high-rate system are discussed. These should be considered when assessing factors such as site capability and levels of soil treatment.

Table 2.2 Characteristics of Slow Rate and Rapid Infiltration systems

Variable	Slow Rate (SR)	Rapid Infiltration (RI)	
		High Rate	Very High Rate
Application	Up to 5 mm/h or 15 mm/event.	n/a	n/a
Annual Hydraulic Load	< 6 m/year	6 m/year to 30 m/year	In excess of 30 m/year but generally not exceeding 150 m/year
Suitable soil types	A wide range of soils that have adequate drainage and support healthy vegetation.	Coarse soils with little to no drainage impediment. Typically sands and gravelly sands. Unlikely over fractured rock.	Very coarse soils with little to no drainage impediment. Typically gravels. Very unlikely over fractured rock.
Treatment characteristics	High level of physical, chemical and biological treatment, including by vegetation. Dispersion, dilution, attenuation, some chemical / biological processes and pathogen removal will also occur in groundwater	High level of physical, biological and chemical treatment is achievable. Vegetation plays minor or no role. Dispersion, dilution, attenuation, some chemical / biological processes and pathogen removal will also occur in groundwater	Limited level of treatment. No vegetative treatment. Dispersion, dilution, attenuation, some chemical / biological processes and pathogen removal will also occur in groundwater
Operational characteristics	Frequent small applications avoid ponding, optimise vegetation uptake and restrict nutrient leaching. Generally: 1. small changes in depth to groundwater after an application; and 2. small groundwater mounding.	Periodic applications that generate saturated soil conditions, interspersed with rest periods to facilitate sorption, aerobic breakdown of organic matter and nitrogen transformation. Potential for: 1. rapid changes in depth to groundwater after an application; and 2. generally moderate to large groundwater mounding.	High volume applications under saturated conditions. Rest periods may be limited. Potential for: 1. rapid changes in depth to groundwater after an application; and 2. large groundwater mounding.

3. Literature Review

A review of relevant literature and existing consents for RIS in New Zealand was completed. The outputs from the review were used to support the development of the RIS Standards Framework (Section 4), and in particular the numeric limits proposed in Section 5. This section sets out the methods applied in conducting the review, the sources consulted, and summarises the information found as relevant to the scope of this work (as per Section 1.3).

3.1 Methodology

The purpose of the literature review was to identify relevant reference materials from within New Zealand, and published internationally, that could help inform development of site selection criteria; identify the risks associated with RIS and provide guidance on what well-performing systems could look like.

The scope for the review included:

– Review of available and relevant literature (e.g. peer-reviewed and published research outputs), industry guidelines and standards related to wastewater disposal to land via rapid infiltration.

– Geographies covered included Australia and the USA where relevant to the New Zealand context. Europe was largely excluded, as earlier work (e.g. T&T 2024) identified that wastewater service providers and applicable standards in Europe are predominantly focused on beneficial reuse.

– Review of existing consents across New Zealand to identify approved and/or operational RIS and collect information from those consents to inform the proposed RIS standards. These consents could also be used to test possible numeric limits and thresholds for application of national standards, to see whether they would be realistic and practicable in the current industry context.

The table below provides a summary of key literature sources considered (but is not exhaustive). All sources are referenced throughout this report and in Section 6 (References) where applicable.

Table 3.1 List of sources that informed the literature review

Jurisdiction	Publisher	Source	Reference (see Section 8)
International			
Global industry	International Water Association	Rapid Infiltration Land Treatment	(Guida, 2021)
Australia			
Victoria	Environmental Protection Agency, Victorian Government.	Guideline for onsite wastewater effluent dispersal and recycling systems	(EPA Victoria, 2024)
United States			
Federal	Office of Water, United States Environmental Protection Agency (USEPA)	Onsite Wastewater Treatment Systems Manual	(USEPA, 2002)
	Office of Water, USEPA	Wastewater Technology Fact Sheet - Rapid Infiltration Land Treatment	(USEPA, 2003)
	USEPA	Process Design Manual - Land Treatment of Municipal Wastewater Effluents	(USEPA, 2006)
	USEPA	Guidelines for Water Reuse	(USEPA, 2012)
Delaware	Delaware Geological Society, University of Delaware	Evaluation of Rapid Infiltration Basin Systems (RIBS) for Wastewater Disposal: Phase 1	(Turkmen, et al., 2015)
Minnesota	Minnesota Pollution Control Agency	Guidance and Submittal Requirements for Rapid Infiltration Basin Wastewater Treatment Systems	(MPCA, 2005)
Nevada	Department of Conservation and Natural Resources, Nevada Division of Environmental Protection, Bureau of Water Pollution Control (NDEP)	WTS-1A: General Design Criteria for Reclaimed Water Irrigation Use	(NDEP, 2017)
	Department of Conservation and Natural Resources, Nevada Division of Environmental Protection, Bureau of Water Pollution Control	WTS-3: Guidance Document for the Permit Application of Rapid Infiltration Basins	(NDEP, 2017)
United Kingdom			
National	Environmental Agency (England) Department of Environment, Food and Rural Affairs (DEFRA)	Infiltration systems: groundwater risk assessments	(Environment Agency & DEFRA, 2016)
New Zealand			
National	Taumata Arowai (Beca, GHD, Stantec)	Technical Advice on Wastewater Performance Standards: Discharge to Land	(GHD, 2025)

3.1.1 Review of New Zealand consents

As noted above, a component of the literature review focused on existing consents issued for RIS in New Zealand.

Taumata Arowai has been developing a national database of wastewater consents, and access to this was granted for the purpose of this work. In addition, the authors contributed publicly available information from RIS that their organisations had been directly involved with or were able to reach out to the consent holders to obtain further information, to supplement (and in some cases, update) the information from the database.

The database reflects key characteristics of publicly operated wastewater treatment plants in New Zealand, based upon consents provided to Taumata Arowai by regional councils. This database has been updated with the best available information by Taumata Arowai, as part of this work, to inform the recommendations provided within this report. However, it requires verification and validation as some information is known to be inaccurate. Information, values and analysis contained in this report which has leveraged the database is therefore subject to change following verification and validation of the database.

Information recorded in the database includes:

- Location (including name of scheme, physical location of WWTP, location of discharge point(s))
- Consent holder and the regulatory authority that issued the consent
- Size of scheme (based on serviced population)
- Consented discharge volume
- Direct and indirect receiving environments
- Type of primary, secondary and tertiary wastewater treatment
- Discharge mechanism (e.g. rapid infiltration)
- Consented application rates, and area over which application is allowed to occur
- Discharge volume (e.g. average or maximum per day)
- Limits for contaminants in the treated wastewater immediately prior to discharge (i.e. ‘end-of-pipe’ limits)
- Limits for contaminants in the receiving environment, after reasonable mixing
- Monitoring and reporting requirements

Wastewater schemes relevant to this work, namely those involving discharges via some form of rapid infiltration, were identified from this database.

Further information about those schemes was then collated from copies of the consent documents, Decision Reports from decision-makers, and relevant consent applications. The purpose of this was to understand the context for some of the limits and requirements imposed, especially where a consent appeared to be an outlier or not aligned with the more common practices across the country.

3.2 Summary of findings

Sources have been referenced throughout this report where they have been drawn upon to develop parts of the Standards Framework. This section summarises the key findings of the literature review, focusing on any obvious knowledge gaps (or where there appears to be a lack of precedent), and definitive trends that emerged.

3.2.1 International literature

The review of international literature focused on finding examples where RIS have been standardised or even regulated in overseas jurisdictions, and capturing information about the success (or otherwise) of different governance approaches. This included identifying precedent(s) for a risk-based approach.

3.2.1.1 Australia

There is no federal standard or set of guidelines for the management of RIS specifically. Wastewater services are typically regulated through the eight State or Territorial Governments in Australia. Services are provided by secondary entities at the regional or local level with a mixture of public-private partnerships, fully privatised providers, and local government authorities.

The regulation of wastewater treatment in general, and the impact of discharges to receiving environments, is based on the National Water Quality Management Strategy (NWQMS). The NWQMS also includes further guidance such as the Australian Guidelines for Sewerage Systems (ARMCANZ & ANZECC, 1997). The latter includes specific guidelines for land application, with “infiltration” considered as an option. Limiting factors for land application via infiltration were listed as being:

- Groundwater – existing and potential environmental values
- Aquifer clogging
- Land – potential for long-term degradation of land and/or crops and vegetation.

The Guidelines specify that the secondary wastewater treatment (targeting TSS and BOD removal) is required at minimum for application systems involving infiltration (ARMCANZ & ANZECC, 1997).

The Victorian Government recently released their *Guideline for onsite wastewater effluent dispersal and recycling systems* (May 2024), which does include guidance for the design and operation of RIS. The guideline uses a risk-based framework and is designed to prioritise systems that demonstrate high treatment reliability. Performance metrics within the guideline (that are applicable to RIS) include targeted reductions in:

- Biochemical Oxygen Demand and Total Suspended Solids (reduction by 95-99%)
- Total nitrogen (reduction by 25-90%)
- Total phosphorus (reduction by up to 90%)
- Faecal coliforms (reduction by at least 99.99%)

Key design variables documented in the EPA Victoria Guideline include effluent load, soil characteristics, climatic conditions, and vegetation cover (EPA Victoria, 2024). Evaporation losses from open beds are less likely to be an important loss mechanism in New Zealand due to our typical weather regime. Vegetation also is expected to take a minor role for RI and no role for VRI systems.

3.2.1.2 United States

At a Federal level, the United States Environmental Protection Agency (USEPA) provides comprehensive guidance on the design and operation of land treatment systems in its Process Design Manual (USEPA, 2006). The manual outlines a multi-step, integrated approach to wastewater management that considers the interaction of effluent characteristics, soil conditions, and environmental sensitivities. This Manual is frequently utilised in many countries around the world, including in New Zealand.

A key feature of the USEPA approach is that system design is largely governed by performance targets and discharge limits to protect groundwater and surface water. Factors such as infiltration rates, soil texture, vertical separation to groundwater, and proximity to sensitive receptors are critical design considerations.

To support system design, the manual recommends:

- Minimum vertical separation of 1.2 metres between basin bottom and the highest seasonal groundwater level
- Setbacks of at least 10 metres from watercourses and 50 metres from potable water sources
- Use of percolation tests and soil analyses to inform loading rates and infiltration basin design
- Consideration of complementary treatment technologies as part of the treatment train, such as phytoremediation to enhance overall treatment efficacy
- Unsaturated (vadose) zone monitoring.

In addition to the above, the factor of safety for the Design Application Rate (USEPA 2004) is also addressed in Section 6. A design safety factor of at least 10 is assumed in the RIS Standard.

The USEPA Manual acknowledges the complexity of site-specific design, where multiple interacting variables must be evaluated. While not structured as a formal tiered risk assessment, the USEPA approach promotes site-specific design solutions that reflect environmental risk, making it compatible with broader risk-based planning frameworks.

Selected State governments have developed tailored frameworks for the management of land application systems, including the equivalent of RIS. One example is the *Guidance and Submittal Requirements for Rapid Infiltration Basin Wastewater Treatment Systems* developed by the Minnesota Pollution Control Agency (MPCA, 2005).

The framework includes three key stages:

1. Baseline Assessment -Identification of existing site conditions, environmental sensitivities, and site constraints.
2. Risk Screening - Preliminary classification of sites into ‘Risk Categories’ based on the nature and scale of potential impacts.
3. Site-Specific Assessment - Evaluation of site capability, termed ‘Site Capability Category’, to determine the extent to which the site can assimilate and treat effluent without adverse impacts.

This tiered structure guides the selection of loading rates, mitigation strategies, and system design elements. The MPCA approach also mandates detailed site investigations to characterise:

- Soil permeability and texture
- Depth to limiting layers or groundwater
- Hydraulic conductivity and infiltration rates
- Land use constraints and regulatory compliance.

This framework allows for both conservatism and flexibility in design - ensuring environmental protection while accommodating the site-specific nature of land-based treatment systems.

3.2.1.3 United Kingdom

The regulation of wastewater services is undertaken at national government level in the UK, with the following agencies sharing key responsibilities:

- Director General of Water Services supported by the Office of Water Services (Ofwat; commercial regulator)
- Department of Environment, Food and Rural Affairs (DEFRA; regulator in England)
- Environmental Agency (England)
- Welsh Government (regulates water services in Wales)
- Scottish Environmental Protection Agency (SEPA)

There are 11 private regional water and wastewater companies and 15 mostly smaller private ‘water only’ companies in England and Wales. In Scotland, services are provided by a single public company, Scottish Water, and in Northern Ireland water services are supplied by a single public entity, Northern Ireland Water.

A detailed review of all regulations, standards and guidance relating to RIS across the UK was beyond the scope of this report, however a couple of examples were considered.

The *Urban Wastewater Treatment (England/Wales and Scotland) Regulations 1994* include requirements to achieve ‘end-of-pipe’ limits for TSS and BOD for discharges into receiving waters, but do not contain similar requirements for discharges to land (or to ground where contaminants may enter water).

The Environment Agency and DEFRA published guidance for infiltration systems (groundwater risk assessments) in 2016; this is available via a government website. The guidance includes recommendations such as appropriate standards to be followed for the design, sizing and installation of RIS (for example, British Standard BS6297:2007) and advocates the use of the Environment Agency’s risk assessment tool to decide how systems that may not meet BS6297:2007 should be managed. The guidance requires that infiltration systems are designed with the following limitations and setbacks (Environment Agency & DEFRA, 2016):

- Minimum 1.2 m above the “seasonally highest groundwater level”
- Avoid discharges on land within 10 metres of a watercourse
- Avoid discharges on land within 50m of a well, spring, borehole or other source of water intended for human consumption
- Avoid steeply sloping or waterlogged land.

3.2.2 New Zealand literature

Key New Zealand sources that informed the development of the RIS Standard included:

- (Robb, et al., 2000) - *Guidelines for the utilisation of sewage effluent on land*, Parts 1 and 2
- AS/NZS 1547: 2012 *Domestic onsite wastewater management*
- (Dairy NZ, 2015) - *A farmer’s guide to managing farm dairy effluent: A good practice guide for land application systems*
- (Banasiak, et al., 2023) – ‘Microbial and solute transport through intact vadose zone cores of heterogeneous alluvial gravel under variably saturated conditions’, *Vadose Zone Journal*, Vol. 22 no. 3, art. no. e20250.
- (Pang, 2009) – ‘Microbial Removal Rates in Subsurface Media Estimated From Published Studies of Field Experiments and Large Intact Soil Cores’, *Journal of Environmental Quality*, July 2009, ESR.

The first two sources are more relevant for slow rate infiltration but contain useful guidance for the lower end of the design application rate for rapid infiltration. The research papers ((Banasiak, et al., 2023), (Pang, 2009)) provided guidance on soil treatment that can be achieved through various design application rates.

3.2.3 Existing RIS consents in New Zealand

A representative 'short list' out of the 21 identified RIS consents, was developed for the purpose of understanding the context for existing NZ consents in greater detail, and in particular to inform the development of the RIS Standard Framework and the proposed numeric limits (Section 5). Criteria used to select the short list included:

- Geographic spread (with a preference for schemes from both the North and South Islands, and a mix of larger urban centres and smaller towns and settlements)
- Scheme size (based on serviced population) – represent large, medium and small schemes
- Variation in wastewater treatment processes prior to discharge
- Consents with existing limits on treated wastewater quality and/or receiving environment quality (e.g. groundwater)
- Schemes that are still operational (as opposed to decommissioned).

The short list is presented in Table 3.2, along with additional information gleaned from the documentation that was publicly available for each scheme at the time of writing.

Table 3.2 Detailed analyses of short-listed RIS consents

Location	Consent holder	Regulatory authority	Date issued	Expiry date	Scheme size	On-site treatment	Discharge mechanism	Application area (ha)	Application surface	Effluent discharge regime	Maximum annual loading rate – TN	Maximum annual loading rate – TP	Consent limits – treated wastewater	Consent limits – receiving environment
Cambridge	Waipa District Council	Waikato Regional Council	27/12/2023	26/09/2058	Large	Screening; grit removal; anaerobic pond; aerated pond; chemical dosing; sedimentation tank; wetland; UV	Rapid infiltration beds until 31/12/2026, Waikato River outfall thereafter	2	Not specified	Discharge to RIBs to be rotated after a maximum of seven days, or when ponding reaches the RIB mid-way point toward the Waikato River (whichever occurs first)	Pre-upgrade commissioning – median total load: 385 kg/day Stage 1 – mean total load: 33.8 kg/day (summer) Stage 1 – mean total load: 71.3 kg/day (winter) Stage 2 – mean total load: 45 kg/day (summer) Stage 2 – mean total load: 95 kg/day (winter)	Pre-upgrade commissioning – median total load: 15 kg/day; 90%ile total load: 30 kg/day Stage 1 – mean total load: 8.3 kg/day Stage 2 – mean total load: 11 kg/day	**cBOD mg/L** Pre-upgrade commissioning – median: 20, 90%ile: 50 Stages 1 and 2 – median: 5, 90%ile: 10 **TSS mg/L** Pre-upgrade commissioning – median: 20, 90%ile: 50 Stages 1 and 2 – median: 5, 90%ile: 10 **E. coli cfu/100mL** Pre-upgrade commissioning: median: 126 Stages 1 and 2 – 95%ile: 14	None
Franz Josef	Westland District Council	West Coast Regional Council	21/01/2019	21/01/2034	Small	Aerated lagoon (for stock effluent); oxidation pond	-	0.48	-	Subsurface soakage trenches	Not specified	Not specified	**BOD_5 mg/L** median: 40, 90%ile: 80 **TSS mg/L** median: 60 **Ammonia N mg/L** median: 20, 90%ile: 40 **E. coli cfu/100mL** median: 20,000, 90%ile: 150,000	None
Kaikoura	Kaikoura District Council	Environment Canterbury	3/10/1996	3/10/2031	Medium	Inlet screen (step screen); aerated lagoon (currently bypassed after 2016 earthquake); anaerobic lagoon; Facultative / Oxidation Pond	Six rapid infiltration beds, eventual discharge to Coastal Marine Area	1.5	Sand	Discharge to RIBs one at a time, over 2-3 days. Total cycle approx. 14 days.	Not specified	Not specified	Not specified	Not specified

Location	Consent holder	Regulatory authority	Date issued	Expiry date	Scheme size	On-site treatment	Discharge mechanism	Application area (ha)	Application surface	Effluent discharge regime	Maximum annual loading rate – TN	Maximum annual loading rate – TP	Consent limits – treated wastewater	Consent limits – receiving environment
Roxburgh	Central Otago District Council	Otago Regional Council	8/10/2010	1/09/2045	Small	Two oxidation ponds in series	Five sets of 3 Infiltration swales; eventually discharge to Clutha River. Dosing system has 5 small radial gates	375 m2 per swale (5,625 m2 total) 0.56 ha	Not specified	Oxidation pond discharges to swales on a “rotation system”. 5 day rest between doses (at dry weather flow), 3 days rest during wet weather flow conditions. 220mm application depth per dose.	Not specified	Not specified	**BOD_5 mg/L** geomean: 35, max: 100 **TSS mg/L** geomean: 70, max 150 **TN mg/L** geomean: 25, max: 35 **TP mg/L** geomean: 10, max: 15 **E. coli cfu/100mL** geomean: 10,000, 90%ile: 500,000	-
Tairua-Pauanui	Thames Coromandel District Council	Waikato Regional Council	30/11/2005	30/11/2030	Medium	SBR; filter; UV	Infiltration beds	Unknown	Unknown	Discharge at Vista Paku not authorised when groundwater levels at MW4 are higher than in MW10 Discharge along median strip of Pauanui airfield not authorised when groundwater in MW14 are higher than at MW10	Annual maximum load: 8760 kg/12 months	Annual maximum load: 3504 kg/12 months	**BOD** 83%ile: 10 **TSS** 83%ile: 10 **Ammoniacal nitrogen** 83%ile: 2 Annual maximum load: 876 kg/12 months **TN** 83%ile: 10 **TP** 83%ile: 5 **E. coli** Median: 14 Maximum: 43 **Faecal coliforms** Median: 14 Maximum: 43 **Enterococci** Median: 4 Maximum: 11	None
Takaka	Tasman District Council	Tasman District Council	23/05/2013	11/06/2038	Medium	Oxidation ponds, floating wetland	Constructed wetland, Rapid infiltration basins (minimum of 8)	-	Gravel	Rest period 5 days (return period >6 days provided under normal operating circumstances)	Not specified	Not specified	Not specified	Trigger values for faecal coliforms in groundwater and for SIN and DRP in Takaka River
Tapawera	Tasman District Council	Tasman District Council	31/07/2007	31/07/2042	Small	Aerated oxidation pond	4 x rapid infiltration basins	Each basin has **floor** area of 289 m2.	100mm thick concrete	Basins dosed in sequence with 7 days’ rest	Not specified	Not specified	Not specified	Groundwater 90th percentile limits for suite

Location	Consent holder	Regulatory authority	Date issued	Expiry date	Scheme size	On-site treatment	Discharge mechanism	Application area (ha)	Application surface	Effluent discharge regime	Maximum annual loading rate – TN	Maximum annual loading rate – TP	Consent limits – treated wastewater	Consent limits – receiving environment
								Total = 1,156 m^2 0.12 ha	splash pad under inlet pipes to basin' rock armouring; 1m unsaturated natural gravels above water table.	between each dose				of parameters including BOD_5 (3 mg/L) ,ammonia N (1.2 mg/L), nitrate N (11.3 mg/L), DRP (0.05 mg/L), E.coli <1 cfu/100mL)
Twizel	Mackenzie District Council	Environment Canterbury	11/04/2018	11/04/2053	Medium	Oxidation ponds	Four 10 m x 100 m infiltration basins	0.4	Gravel	Basin operational cycle: - Application period = 2 days - Drying period = 6 days - Total cycle = 8 days - Application rate = 46 cycles per year	Predicted TN **inflow** load in 2033: 26-41 kg/day Predicted TN **inflow** load in 2048: 32-50 kg/day	Not specified	Not specified	Not specified
Wanaka	Queenstown Lakes District Council	Otago Regional Council	9/07/2007	30/09/2041	Medium	SBR; filtration; UV	Rapid infiltration trenches	Each trench approximately 2 m wide and 100-120 m long, approximately 13.2 ha of effective basal trench area	Gravel	Majority of trenches to be utilised during peak wet weather flows; trenches to be rested and rotated during dry weather flows	Predicted peak wet weather flow in 2040: 8,760 kg/ha/year Predicted peak dry wet weather flow in 2040: 3,982 kg/ha/year Predicated 80%ile peak wet weather total load: 317 kg/day Predicted 80%ile peak dry weather total load: 144 kg/day	Predicated 80%ile peak wet weather total load: 290 kg/day Predicted 80%ile peak dry weather total load: 132 kg/day	**BOD** 80%ile: 35 **TSS** 80%ile: 35 **TN** 80%ile: 12 **E. coli** 80%ile: 1000	Groundwater nitrate maximum: 11.3 g/m^3 Groundwater E. coli maximum: 1 cfu/100mL

4. RIS Standard Framework

The recent Priority Item reporting supersedes some of the information in this Section of the Report. Therefore, this report must be read in conjunction with the Discharge to Land Priority Item reporting, Appendix A. Superseded information has been struck out

The approach adopted for the RIS Standard (termed the RIS Standard Framework) has been generally aligned with that of the Discharge to Land Standards for Slow-Rate Application of treated wastewater (GHD et. al. 2025) which is a risk-based approach used to determine which set of limits to apply to discharges of treated wastewater to land. A high-level schematic of the RIS Standard framework is shown in Figure 4.1.

A Risk-based approach has been incorporated into the RIS Standard Framework for a number of reasons:

– It is a well-established and universally accepted method for understanding and managing risk associated with activities that might impact on infrastructure, the natural environment, socio-cultural values, and the economy.
– There are existing frameworks to draw upon, such as the International Standard for Risk Management – Guidelines (Second edition, 2018-02; ISO 31000). This framework in particular is applied in the context of workplace health and safety; environmental management (including for climate change adaptation and flood risk assessments); options assessment to inform engineering design, and infrastructure / asset management and planning, to name a few examples.
– It is an approach that majority of experienced practitioners in the wastewater industry (both in New Zealand and globally) will be familiar with, and therefore it can be adapted as required to suit their project's needs as well as those of the regulators (regional councils) and Taumata Arowai.

ISO 31000 outlines a process that includes:

– **Identification:** Identifying potential risks.
– **Analysis:** Understanding the nature and potential impact of risks.
– **Evaluation:** Determining the acceptability of identified risks.
– **Treatment:** Developing strategies to address risks, such as avoidance, mitigation, or acceptance.

These steps underpin the approach and are detailed further below.

1. **Baseline Assessment (Section 4.1)**

   A high-level, desktop feasibility study, which considers the key attributes of the proposed location of the RIS. The assessment can be used for early identification of any 'unsuitable' conditions present on the site, that cannot be avoided or mitigated.

2. **Hazard and Risk Identification (Section4.2)**

   A risk assessment for the discharge of treated wastewater onto land via a RIS is undertaken, and a **Risk Level** is determined. This assessment includes consideration of the risk equation. Risk = source[2] x pathway[3] x receptor[4].

3. **Site-Specific Assessment (Section4.2)**

   Involves bringing together information obtained from Steps 1 and 2 to confirm the capability of the site to receive and assimilate the discharge without unacceptable effects on receptors (i.e. the **Site Capability Category**). The **Risk Level** is also re-confirmed as part of this assessment (by undertaking additional investigations to confirm assumptions made from the desktop review in Step 1).

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[2] Source: The hazard at the source, i.e., nitrogen, phosphorus, etc, considering the assigned numerical limits.
[3] Pathway: By contact with surface water, groundwater or land, where the exposure pathway is indirect (i.e., there are intermediate receptors between the source and the final receptor) or direct (i.e., direct contact with wastewater discharging to surface water).
[4] Receptor: The environmental or human health receptor impacted at the end of the pathway

4. **Refinement and Re-evaluation (Section 4.3)**

Where unacceptable risks have been identified, the asset owner can identify control and mitigation measures (through design and operational considerations) which may assist in reducing the Risk Level or the Site Capability rating so that the RIS can be re-assessed as having a lower risk of adverse effects to receptors. This would allow for less stringent numerical limits to be applied.

Once these steps are complete, an appropriate set of numeric limits can be selected (as detailed in Section 5).

The Framework is reiterative, allowing for further assessment or mitigation to be undertaken where needed to revise the risk assessment and reduce the documented risks to an acceptable level (where 'acceptable' is determined by the parameters and criteria of the RIS Standard Framework). This aligns with the 'precautionary approach'; where a RIS can be demonstrated as relatively low risk, the assessment can be completed, and the scheme consented in a quicker and more cost-effective manner than for a higher-risk RIS.

The output of the risk assessment process is a **Risk Level** that is assigned to each of the risks identified for a RIS. The **Risk Level** is then considered in combination with the **Site Capability Category** (refer to Section 4.2.2) to determine which **Standard Class** should apply to a RIS.

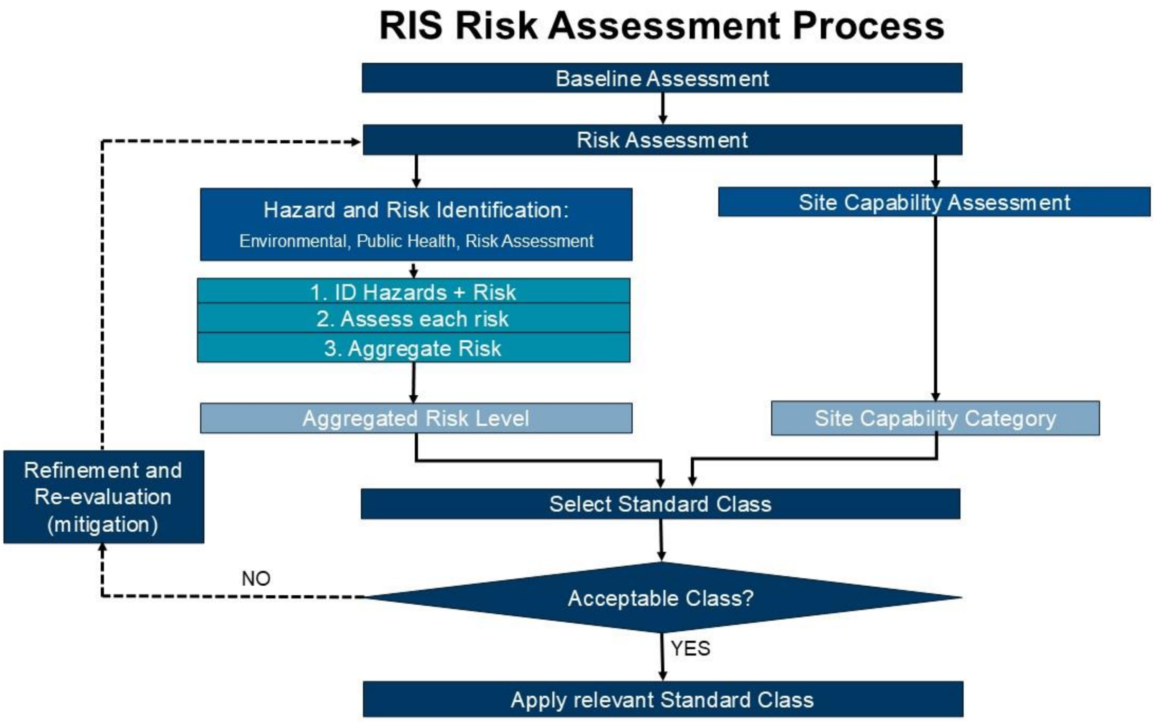

Figure 4.1 Schematic of Risk-based process under RIS Framework

The RIS Standard Framework has been designed to ensure that a consistent approach to risk assessment for RIS is undertaken across New Zealand, and to help users of the Standard to understand what different levels of risk look like in this context. This is especially important as risk assessment can sometimes be subjective; it is susceptible to constraint by the perspectives and knowledge held by the assessors. For this reason, it is assumed that the risk assessment process will be carried out by subject matter experts and be reviewed by an experienced practitioner who was not involved in the initial risk assessment process.

4.1 Baseline Assessment

Note that the information presented here in Section 4.1 has been superseded by Section 4, Priority Item 13 of the DtL Priority Item report (Appendix A).

~~Baseline assessment requirements will be detailed in guidance accompanying the RIS Standard. The baseline assessment is to be completed as a desktop feasibility assessment on a prospective land parcel, including but not limited to:~~

- ~~Rainfall (total annual and probability of extreme events) particularly focused for areas with frequent intense rainfall~~
- ~~Site physical attributes – i.e. slope / topography,~~
- ~~Initial estimate of area required based on hydraulic loading, with conservatism (i.e., space available for the system, allowing for rest periods, expansion, buffer zone)~~
- ~~Available groundwater data (use, depth to water table, quality and temporal trends, flow direction, seasonal and event variation, sensitivity, connection to surface water).~~
- ~~Available soil data – types, drainage capacity, heterogeneity (from regional and national maps, i.e. S-map)~~
- ~~Underlying geology (characteristic of the unsaturated zone (where water will flow through), consideration of drainage impediment)~~
- ~~Required buffer distances to sensitive receptors~~
- ~~Site contamination history~~
- ~~Current and proposed land use within potential application area (consider ownership)~~
- ~~Identify potential receptors, proximity and sensitivity (including environmental, human / social, cultural, built environment). Consideration should be given to immediate and ultimate receiving environments.~~
- ~~Natural hazards[5] such as flood-prone land and instability, and future climate risk (e.g. sea level rise).~~
- ~~Site hydrology (i.e., drainage conditions, recharge, connection to groundwater)~~
- ~~Existing environmental pressures in the catchment (i.e., cumulative effects)~~

4.2 Hazard and Risk Identification

Note that the information presented in Table 4.1 below has been superseded by Table 5, in Section 5.2.1 of the DtL Priority Items report provided in Appendix A.

As described above, the first step in the risk assessment process is to **identify** the risks that are potentially associated with a RIS. Since it is assumed that the RIS is appropriately designed, operated and maintained by a suitably qualified practitioner (as per Section 1.4), these are primarily environmental and human health risks. The assessment cannot be undertaken without first having a good understanding of the context in which a RIS will be operated, and identifying the sources, pathways and receptors that are present (as set out in Figure 4.2 below). This identification process should initially be informed by the Baseline Assessment, described in Section 4.1.

The environmental and public health risks associated with the discharge of treated wastewater to land via RIS are governed by the nature of potential hazards, the receptors that may be affected, and the pathways connecting them. The wastewater treatment and discharge process can give also rise to social and cultural risks; these are beyond the scope of this evaluation but are very important for asset owners to consider. Figure 4.2 below illustrates the key components of risk assessment and the relationships between them, as defined in standard methodologies (such as that described in ISO 31000) and as relevant to the RIS Standard. Appendix D contains some support information to assist with understanding this approach.

A list of hazards and associated risks that need to be considered as a minimum is provided in Table 4.1. Appendix C contains several examples of the different types of hazards that may be present for a RIS, and the risks and potential outcomes associated with them. This is not an exhaustive list but is designed to illustrate the intention behind the hazard types to be considered when completing the Risk Assessment required by the RIS Standard.

In addition, Appendix C also lists factors that typically influence the robustness and outcomes of the risk assessment process for treated wastewater discharge to land. These influence both the assessment's scope and the confidence in its results.

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[5] During baseline assessment, Regional and District plans will need to be checked for restrictions regarding social, cultural and ecological requirements. In addition, they should be checked for natural hazards, i.e., sites with an unacceptable risk will have already been excluded (e.g. flood-prone land). However, these plans and maps can be confirmed during natural hazard categorisation assessment.

Table 4.1 ***Minimum hazards and associated risks that need to be considered. Note that this table has been superseded by Table 5, in Section 5.2.1 of the DtL Priority Items report provided in Appendix A.***

~~Hazard Type~~	~~Risk~~
~~Environmental~~	~~Contamination of groundwater compromising the potential future use~~
	~~Contamination of Surface Water~~
	~~Release of toxicants ammonia and nitrate to groundwater or surface water~~
	~~Release of Nitrogen, Phosphorus leading to eutrophication~~
	~~Buildup of Phosphorous in soils which compromises current or future use of the site~~
	~~Mobilisation of existing contaminants such as Nitrogen and Phosphorous where the catchment is already at or close to Regional Catchment Nutrient Budget~~
	~~Existing monitoring and compliance record signals that the site is not working well and likely to be releasing nutrients or pathogens to receptors~~
~~Public Health~~	~~Drinking water protection zone is compromised leading to public health warning due to nitrate, pathogens or viruses~~[6]
	~~Domestic private drinking water bore is compromised leading to public health notice due to nitrate, pathogens or viruses~~
	~~Release of indicator organisms to a level that causes exceedance of contact recreation guidelines Illness due to contact recreation~~
	~~Mobilisation of existing contaminants such as Nitrogen and P where these are already elevated at or close to MAV.~~

[6] MfE 2018 Technical Guidelines for Drinking Water Source Protection Zones

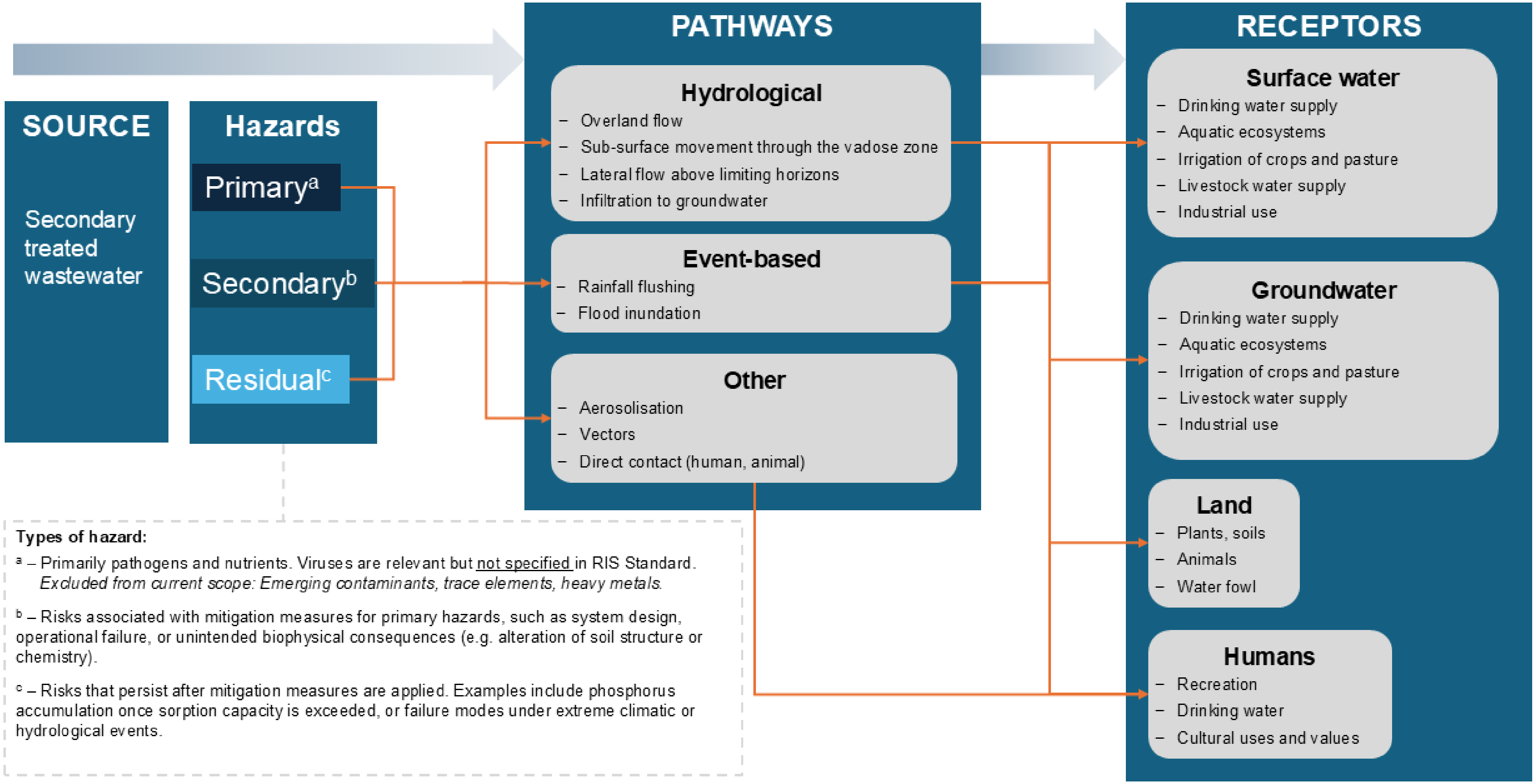

Figure 4.2 Overview of the risk assessment process

4.2.1 Determining the Risk Level

Note that the information presented in Table 4.2 and Table 4.4 has been superseded by Table 6 and Table 8, respectively, in Section 5.2.2 of the DtL Priority Items report provided in Appendix A.

A **Risk Level** is assigned to each of the risks identified for a RIS. This is determined by assessing the following (as per ISO 31000):

– The **likelihood** of events and consequences occurring as a result of the risk
– The nature and magnitude of the **consequences**.

It is necessary to clearly define what different levels of likelihood and consequence look like to reduce the amount of subjectivity that can be inherent in risk assessment. A high-level review of literature from the water industry was conducted, to develop appropriate sets of definitions for the RIS Standard.

The review considered the following examples:

– Risk matrices used in (drinking) water safety planning throughout North America, South Africa, Australia and New Zealand (evaluated in research by (Lane & Hrudey, 2023))
– The Victorian Guidelines for Water Recycling, Australia (EPA Victoria, 2021)
– The New Zealand Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas (MfE, 2003)
– Ecological Impact Assessment (EcIA) – EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems (Roper-Lindsay, et al., 2018)

Appendix E contains examples of different definitions from these sources. The final definitions for **likelihood ratings** selected for the RIS Standard are shown in Table 4.2.

Definitions for **consequences** have been developed for environmental risks, public health risks, and for risks to drinking water supplies form both groundwater and surface water sources. The final definitions for **consequence ratings** selected for the RIS Standard are shown in

Table 4.3.

A Risk Level can be assigned once the likelihood of events and consequences occurring as a result of the risk and the nature and magnitude of the consequences have been determined. Table 4.4 shows how the Risk Level is assigned for **each individual risk identified** in a RIS.

The initial assessment of Risk Level is completed with the assumption that **no mitigation measures need to be applied**.

Table 4.2 ***Definitions of likelihood ratings. Note that this table has been superseded by Table 6, in Section 5.2.2 of the DtL Priority Items report provided in Appendix A.***

~~**Likelihood rating**~~	~~**Definition**~~
~~Almost certain~~	~~Is expected to occur in most circumstances (>85% chance of occurring)~~
~~Likely~~	~~Will probably occur in most circumstances (55% to 85% chance of occurring)~~
~~Possible~~	~~Could occur (30% to 55% chance of occurring)~~
~~Unlikely~~	~~Could occur but not expected (5% to 30% chance of occurring)~~
~~Rare~~	~~Occurs but only in exceptional circumstances (<5% chance of occurring)~~

Table 4.3 Definitions of consequence ratings

Consequence rating	Definition – Public Health	Definition – Environmental
Insignificant	Illness resulting from the treated wastewater discharge is indiscernible above the normal background level of illness in the community.	Small scale pollution or other environmental damage is localised with no resultant effects. Any changes in environmental condition are not discernible from baseline. Contained locally. None related to the discharge
Minor	Health effects are limited to a single person, single household or single group of people. Any persons affected experience a minor illness (e.g. minor gastrointestinal illness)	Minimum pollution or other environmental damage. Minor shift away from existing baseline conditions. Short-term effects only
Moderate	Health effects affect a larger group of people across a wider area, Any persons affected experience a minor illness (e.g. minor gastrointestinal illness).	Repeated departure from existing baseline conditions with discernible adverse effect at localised level. Effects over medium term.
Major	Health effects affect a larger group of people across a wider area. Persons affected experience a moderate illness (e.g. norovirus, where hospitalisation may be required), which may be dangerous to sensitive members of the community.	Significant and widespread pollution or other environmental damage, major departure from existing baseline conditions with long-term effects (but these effects could still be remedied).
Extreme	Health effects affect a larger group of people across a wider area. Persons affected experience a major illness, which is likely to be dangerous to sensitive members of the community.	Permanent (irreversible) alteration to baseline condition with fundamental changes to the aquatic ecosystem.

Table 4.4 Risk Level Matrix. Note that this table has been superseded by Table 8, in Section 5.2.2 of the DtL Priority Items report provided in Appendix A

		~~Consequence~~				
		~~Insignificant~~	~~Minor~~	~~Moderate~~	~~Severe~~	~~Extreme~~
~~Likelihood~~	~~Almost Certain~~	~~Low~~	~~Medium~~	~~High~~	~~Critical~~	~~Critical~~
	~~Likely~~	~~Low~~	~~Medium~~	~~High~~	~~Critical~~	~~Critical~~
	~~Possible~~	~~Low~~	~~Medium~~	~~Medium~~	~~High~~	~~Critical~~
	~~Unlikely~~	~~Low~~	~~Low~~	~~Medium~~	~~Medium~~	~~High~~
	~~Rare~~	~~Low~~	~~Low~~	~~Low~~	~~Low~~	~~High~~

4.2.2 Determining the Site Capability Category

Note additional supporting information on determining the site capability is provided in Section 5.3 of the DtL Priority Items report provided in Appendix A.

In addition to assessment of environmental and public health risks, the suitability of a site for RIS is also dependent on the site attributes. Site attributes should be considered in terms of the sites capability to accept, treat and transport the treated wastewater in a manner that meets appropriate receiving environmental and public health performance requirements. The objective of this stage of the proposed process is to consolidate key interacting factors into a single classification system (assigning a **Site Capability Category** for the proposed RIS setting). The evaluation should therefore be conducted by suitably qualified and experienced practitioners in the relevant fields (e.g. soil science, hydrogeology). The results of the evaluation should be compared against the information and assumptions of the Baseline Assessment to confirm the Site Capability Category is appropriate for the site.

If the evaluation concludes a marginal (Category 4) or potentially unsuitable (Category 5) ranking, further site investigations (i.e. in the field) may be initiated to derive empirical data for the site and revise the ranking. Site-specific investigations are essential to evaluate the suitability of the site for assimilating and treating wastewater by rapid infiltration, and to establish a record of soil and groundwater parameters prior to the design, construction and commissioning of a scheme. If further site investigations conclude a Category 5 (unsuitable) ranking and mitigations cannot be applied to reduce the ranking (see Section 4.3), then the standards do not apply.

Table 4.5 presents factors that must be considered at a minimum. It is recommended that the selected Site Capability Category also accounts for interactions between these factors.

The overall Site Capability Category for the RIS is the highest (i.e. most precautionary) Site Capability Category based on all factors considered.

Table 4.5 Site-Capability Category criteria

Factor	**Category 1** ***(Ideal)***	**Category 2** ***(Minor limitations)***	**Category 3** ***(Limitations)***	**Category 4** ***(Marginal)***	**Category 5** ***(Unsuitable)***	**Technical basis**
Drainage	Very well drained. Free of any drainage impediment in Vadose Zone.	Well drained. Free of any drainage impediment in Vadose Zone.	Moderately well drained. Free of any drainage impediment in Vadose Zone.	Imperfectly drained.	Poorly drained.	Adapted from Landcare S-map. and ASNZ/1547
Soil type	Well graded sands and sandy gravel; gravel cobbles (with limited silt/clay <10%); pumice.	Fine sand; loamy sand; sandy loam	Clay loam; silty clay loam with adequate structural development	Heavy textured clays and silty clays with limited structural development.	High risk soils (heavy clay, peat, water repellent soil)	Adapted from a range of references including (Milne, et al., 1995), (USEPA, 2006) and ASNZ/1547.
Slope	Flat	Low relief <5°	5 - 10°	10 - 15°	>15° unless feasible to regrade.	(Chakir, et al., 2023) state that slopes for RIS, a basin construction must not exceed 15%. Sites containing a slope of 0%–5% are most appropriate.
Depth to Groundwater	Shallowest depth to GWL (including groundwater mounding) >5 m	Shallowest depth to GWL (including groundwater mounding) >3 m	Shallowest depth to GWL (including groundwater mounding) between 3 and 1.5 m	Shallowest depth to GWL (including groundwater mounding) between 1.0 and 1.5 m.	Shallowest depth to GWL <1.0 m	Unsaturated zone thickness from (USEPA 2006) Table 1.2, for SAT: Cat 4: 3 m to 1.5 m during drying Cat 5: < 1 m during an application event; < 1.5 m during drying. Unsaturated zone thickness greater than the US EPA standard of 3 m allows for greater pathogen removal.

Notes:

1. Soil suitability should consider the capacity to assimilate wastewater, including physical characteristics such as permeability, water holding capacity, structure and texture as well as physico-chemical and biological considerations such as Phosphorus Retention Index, soil pH, organic matter content and exchangeable cations.
2. Regional and District Plans will be checked during the Baseline Assessment i.e. sites with an unacceptable risk will have already been excluded (e.g. flood-prone land). However, these plans and maps can be confirmed during natural hazard categorisation assessment.
3. Sufficient land should be available to accommodate land application of wastewater, separation distances to property boundaries and surface waters, a reserved area (if required by designer), and sensitive cultural and ecological site
4. For all sites consider climatic conditions including rainfall, temperature (freezing) and extreme events.
5. Reference: USEPA 2006
6. Consideration should have been given during the Baseline Assessment to nationally or regionally significant social, cultural, or ecological areas.
7. The minimum unsaturated zone factors account for groundwater mounding.

4.2.3 Aggregated Risk Level

Note that the information presented below and presented in Table 4.6 has been superseded by Section 5.2.3, and Table 9 of the DtL Priority Items report provided in Appendix A.

~~Two factors will influence the overall Risk Level that is assigned to the RIS, and used in combination with the Site Capability Category to determine the Standard Class that applies:~~

- ~~The number of hazards (and associated risks) that were identified in the first step (Section 4.2)~~
- ~~The proportion of the total number of risks that are assigned a **Risk Level** of 'High' or 'Critical' (Section 4.2.1).~~

~~Once the initial risk assessment is complete, the following analysis should be undertaken:~~

1. ~~Calculate the proportion of all risks that are assigned as 'High' or 'Critical'.~~
2. ~~Select the appropriate overall Risk Level for the RIS based on Table 4.6 below.~~

~~*Table 4.6 Criteria for assigning Overall Risk Level for a RIS Note that this table has been superseded by Table 9, in Section 5.2.3 of the DtL Priority Items report provided in Appendix A*~~

~~Overall Risk Level~~	~~Criteria~~
~~Risk Level 1 (Lowest)~~	~~Less than 25% of the identified risks have been assigned a Risk Level of 'High' or 'Critical'.~~
~~Risk Level 2~~	~~25% or more of the identified risks have been assigned a Risk Level of 'High' or 'Critical'.~~
~~Risk Level 3~~	~~50% or more of the identified risks have been assigned a Risk Level of 'High' or 'Critical'.~~
~~Risk Level 4 (Highest)~~	~~75% or more of the identified risks have been assigned a Risk Level of 'High' or 'Critical'.~~

4.2.4 Overall Classification of RIS

Once the aggregated risk and site capability is determined then the **Standard Class** to be applied to the site can be identified; with Class 1 being applied to the sites which have a high capability to accept and further treat the secondary treated wastewater and relatively low level of environmental and public health risk.

Conversely a Class 3 location has less capability for additional treatment and often a higher aggregated risk level. In this case, if desired and possible, mitigation can be applied to improve the classification and change the numerical limits that apply.

The following steps should be taken:

1. Combine the overall **Risk Level** and the **Site Capability Category** to determine which **Standard Class** will apply (as per Table 4.7).
2. If the outcome is not acceptable (for example, the applicable **Standard Class** is not financially feasible, or is considered too stringent to achieve with the treatment system available, or the standards cannot be applied), then the risk assessment is re-iterated to account for mitigation measures, design and operational considerations, and/.or weightings for different types of risk (to be determined in consultation with stakeholders and the regulatory authority). This process is further described in Section 4.3 below.

Table 4.7 Matrix for selection of applicable Standard Class

		Site Capability			
		Category 1	**Category 2**	**Category 3**	**Category 4**
Risk	**Level 1**	Class 1 loading rates apply	Class 1 loading rates apply	Class 2 loading rates apply	Class 3 loading rates apply
	Level 2	Class 1 loading rates apply	Class 2 loading rates apply	Class 2 loading rates apply	Class 3 loading rates apply
	Level 3	Class 2 loading rates apply	Class 2 loading rates apply	Class 2 loading rates apply	Class 3 loading rates apply
	Level 4	Class 2 loading rates apply	Class 2 loading rates apply	Class 3 loading rates apply	**Standards cannot be applied[1]**

Notes:
Standards cannot be applied to Site Capability Category 5 regardless of risk level, unless mitigations can be applied to reduce the Site Capability Category ranking.

4.3 Refinement and re-evaluation

A key step within the refinement and re-evaluation process is to consider whether any appropriate mitigation measures could be applied to reduce the level of risk associated with one or more risk factors or to improve the sites capability assessment. Ideally, measures that could reduce several risks at once would be given preference.

A list of potential mitigation measures that can be applied to RIS is provided below, based upon the authors' practical experience as well as published literature (e.g. (EPA Victoria, 2024); (Gov.UK, 2016); (USEPA, 2006)).

- Restrict public and livestock access to discharge location
- Provide an alternative drinking water supply for affected downgradient users
- Treat domestic supply (that is reliant on potentially affected groundwater or surface water)
- Increase level of treatment at WWTP
- Increase certainty through field trials / monitoring
- Assess alternative sources of contamination from the surrounding catchment
- Reduce loading to site and/or increase land area for discharge
- Adjust operational cycles/ practices to remove more Nitrogen (e.g. by increasing denitrification losses)
- Storage provision and/or dual discharge to surface water and land
- Install upgradient groundwater cut off drains and diversions to lower the water table
- Reduce overall loading to site by increasing the RIS treatment area
- Pretreatment (e.g. biochar for phosphorus removal)
- Incorporate imported material (e.g. sand) as a "sacrificial" layer to improve filtration on the application area
- Downgradient denitrification trenches (converting ammoniacal N in groundwater to nitrate and additional N removal via denitrification)
- Increase buffer distances (to sensitive receptors) via relocating RIS treatment area within the site
- Increase the effectiveness of the buffer selected (e.g. planting species in the buffer zone for increased nutrient uptake via phytoremediation).

Note, a refined list of potential mitigation options is also presented in Section 5.5 of the DtL Priority Items report provided in Appendix A.

5. Proposed limits for treated wastewater quality

The RIS performance is typically evaluated using operational metrics and environmental outcome measures. Operational metrics are expected to include monitoring of the influent wastewater discharged to the RIS (i.e. quality of the treated wastewater from the wastewater treatment plant).

A high degree of physical filtration performance is afforded by RIS, as documented in the literature. Therefore, limits for the solids or BOD content in the influent to the RIS have not been proposed. Soils have extraordinarily high capacity for BOD treatment if adequately aerated and managed via cycling of the treated wastewater discharge to land. These aspects are considered to be design decisions (as discussed in Section 4 above).

The purpose for the limits proposed for the RIS Standard is to protect human health and the environment. Numerical limits, defined for key wastewater constituents, provide an objective basis for determining compliance with environmental standards and inform both design and monitoring requirements.

The limits in Table 5.1 were developed with reference to available literature and existing consents for RIS across New Zealand (as described in Section 3). In addition to site capability and risk, the derivation of the limits has considered the following elements:

– Quality of the treated wastewater.
– Treatment through the soil matrix.
– Receiving groundwater quality.
– Transport pathways and further treatment/decay of contaminants through these pathways.
– Environmental and public health requirements in ultimate receiving waters.

Potential public health risk posed to drinking water sources. It is intended that once the process described in Sections 4.1 through 4.3 above has been followed, an asset owner would select the applicable set of limits based on the appropriate risk classification for their site.

Table 5.1 Proposed numeric limits for the treated wastewater discharged on or into land in RIS[78]

Standard Class	Total nitrogen (kg/ha/yr)	Total phosphorus (kg/ha/yr)	*Escherichia coli (E. coli) concentration (cfu/100ml)*
1	20,000	7,000	100,000
2	10,000	3,000	10,000
3	4,000	1,000	1,000

Notes:

The numerical limits for TN and TP represent the maximum annual loading rate. The TN and TP annual loading rate is calculated by dividing the annual load by the land application area (site). The annual load is calculated as the sum of the monthly load using the total volume of treated wastewater discharged over the month and concentration for the treated wastewater recorded for that month. This is calculated using the total volume of treated wastewater discharged over the year and median concentration for the treated wastewater. The **Site** is the area over which the treated wastewater is directly applied.

For **sites** less than 1-hectare with a total application area less than 1-hectare or containing point source discharges:

- Load is calculated as an average over a nominated 1-hectare area (i.e.: it is normalised to 1 ha).

For **sites** greater than 1-hectare:

- Load is calculated directly on a per hectare basis in relation to the area over which the treated wastewater is applied.

For all **sites**:

Load includes total nitrogen and total phosphorus from all other sources within the nominated 1-hectare area.

The numerical limits for *E.coli* represent the annual 90th percentile. This is calculated from the treated wastewater monitoring results for concentration of *E.coli* for a given year

Class 1 sites have the highest site capability (factors such high soil treatment) and lowest risk to receptors. In contrast Class 3 sites have the lowest site capability (factors such a low soil treatment) and highest risk to receptors.

5.1 Technical basis

The technical basis for the numerical limits is summarised below. A precautionary approach was adopted by considering the loading rate limits across the three different methods below and where relevant choosing precautionary variables for more challenging treatment capability scenarios where ranges were available e.g.: nutrient removal rates through RIS systems on sites with poor treatment capability.

The *E. coli* concentration limits were calculated working backwards from an assumed concentration of 100 cfu/100ml in the drainage water directly below the discharge at the point it reaches the water table, before mixing with the aquifer. The higher Class 1 and Class 2 limits reflect a greater amount of treatment via the land application process at these sites. The removal rates were based off literature values for RIS (USEPA, 2003) and typical bacterial removal rates in sand and gravel material for a vadose zone thickness ranging from 1 m to 5 m after Pang (2009). The limits align well with typical concentrations in secondary treated wastewater for standard to higher levels of treatment.

The Total Nitrogen and Total Phosphorus loading limits were assessed considering three methods. As a sense check, the limit classes were checked against Method 3 to ensure a reasonable fit to a typical range of existing New Zealand RIS.

- Method 1 involved multiplying representative secondary treated wastewater concentrations (10, 20 and 30 mg/L total nitrogen and 8, 6 and 4 mg/L total phosphorus) by the 30th percentile, median and 70th percentile annual hydraulic loading rate (29, 61 and 113 m/yr) calculated from New Zealand RIS sites and converting this to a per hectare, per year loading rate for each numerical limit class.
- Method 2 compared nutrient loads from the dairy sector by scaling typical leaching data from a typically sized New Zealand dairy farm. This approach was suitable for making a coarse catchment-scale comparison of potential environmental effects. The leached load per hectare from a typical dairy farm was multiplied by 100 to reflect a small to medium (100 ha) farm's total impact, enabling comparison with RIS application sites where the application footprint is much smaller but the rate at which the treated wastewater is applied is generally much higher. The wastewater application load was derived to reflect expected reduction in the vadose zone by increasing the RIS leached loading rate using standard nitrogen and phosphorus removal rates from relevant literature (Victoria EPA, 2024, USEPA, 1980 and USEPA, 2006) and expected for New Zealand conditions. It should also be noted that the RIS serves the connected township (such that discharge of wastewater to land within the township's footprint is not undertaken), such that the area of the township will itself contribute minor nitrogen and phosphorus loads to the catchment. Hence, in some degree, offsetting the total load from a catchment scale perspective.
- Method 3 involved an assessment of loading rates from twelve of the 21 New Zealand RIS listed in the Taumata Arowai Consent Database. The RIS sites covered a range of site capabilities. For RIS with a discharge area less than 1 ha, the loading rates were calculated based on 1 ha rather than the actual discharge footprint to "normalise" all loading rates to a per hectare basis.

6. Critical design, operation and site management requirements

The recent Priority Item reporting supplements some of the information in this Section of the Report. Therefore, this report must be read in conjunction with the Discharge to Land Priority Item reporting, Appendix A

There are critical design considerations, operational activities and site management requirements that will assist in reducing risks and extending the operational life of the scheme and associated infrastructure. Including the application of factors of safety (typically at least 10). The RIS Standard and numerical limits assume that the site is designed appropriately and well operated and maintained. Therefore, the RIS Standard does not explicitly define these requirements, as it is understood that these will vary between schemes and will be assessed and addressed either during design or as part of the operational procedures for the site. These will be determined by the asset owner in consultation with the designers and the applicable regulatory authority where required. It is intended that guidance resources will be prepared by Taumata Arowai in the future to provide further detail and achieve national consistency in how these requirements are achieved. This section provides a starting point for the development of that guidance.

The following parameters are fundamental to design:

– **Design Application Rate**

  The design application rate (DAR) is based on international experience to ensure sustainable percolation through the unsaturated zone over time, and should be equal to between 4% and 10% of the measured permeability of the most limiting soil layer in the unsaturated zone.

  Additional notes: The small percentage accounts for clogging over time due to BOD and other solids, intermittent applications (reaeration), the variability of the actual soil permeability within a site, and the potential reduction with time. A lower percentage should be adopted for sites with highly variable soils or where there are other uncertainties.

  The procedure is to calculate the application rate based on a percentage of the soil permeability. This value is then compared to the loading rate based on treatment requirements and the lower rate is selected for design. The basin infiltration test and the cylinder infiltrometer test can be used to measure the infiltration rate at the soil surface. The disc permeameter method is also excellent for this purpose because it maintains a constant head. The "Amoozemeter" method can be used for measurements of soil permeability at depth in boreholes advanced for that purpose (see below).

– **Soil Permeability (saturated vertical conductivity)**

  The rate at which water moves vertically through a fully saturated soil under the influence of gravity and a hydraulic gradient.

  Additional notes: Vertical hydraulic conductivity measurements overestimate the wastewater infiltration rates that can be maintained over long periods of time. For this reason, and to allow adequate time for drying periods and for proper basin management, annual hydraulic loading rates should be limited to a fraction of the measured clear water permeability of the most restrictive soil layer as noted above.

– **Limiting Design Parameter (LDP)**

  This is the concept that one factor is expected to dictate (control) the sustainable application rate suitable for any given site/ The LDP Is determined after considering the area available for RIS treatment, the soil permeability, organic loading, nutrient balance, and required pathogen reduction.

  Note: The LDF controls the design and establishes the required size and loadings of a system.

RIS performance is a function of multiple variables. The design process will involve iterations each being influenced by subsurface flow path modelling, groundwater response modelling, further site investigation results, the nutrient balance and other information inputs. A final WWTP RIS design will be predicated on the water quality needs of the targeted receptors and the necessary degree of confidence in achieving this.

Additional **critical design considerations** for RIS include:

- Storage requirements and method/s
- Distribution mechanism design
- Supporting hydraulic infrastructure
- WWTP concept design (where the RIS is taken into consideration) and detailed process design
- Treatment requirements
- Aquifer characteristics
- Hydraulic loading rates and other parameters (including consideration of groundwater mounding)
- Land area requirements
- Hydraulic loading cycle
- Basin layout: distribution detail: construction constraints
- Cold weather operation
- Drainage maintenance design
- Risk and mitigation assessment – a final review of detailed design output, associated operational risks and mitigation measures
- Process control and instrumentation design
- Safety in Design review (including consideration of the scale of the plant)

RIS treatment is also heavily influenced by operational factors such as the dosing cycles (duration, frequency and rest periods) which needs to be accounted for in the design process to ensure adequate rest periods are maintained between applications. Intermittent saturated conditions also facilitate anaerobic conditions in the soil for nitrogen loss via denitrification.

Operational and site management requirements typically include:

- Detailed operation and maintenance manual
- Routine operation and maintenance schedules covering infrastructure condition, electrical and mechanical equipment performance, land application area condition and infiltration rate monitoring facilities, and associated routine maintenance or ‘maintenance-on-demand’
- Environmental effects assessments and monitoring; such as implementing resource consent requirements, and using monitoring data from wells to calibrate groundwater models and continually review effects
- Draft management plan(s) for site operations covering personnel and responsibilities
- Regulatory output scheduling
- Asset management planning
- Preventative / corrective inspection and maintenance schedules, and monitoring schedules
- Emergency Response and Contingency Plan
- Operational Health and Safety Plan
- Audit and Review Processes

Note guidance on the contents of the Operation and Maintenance Manual are outlined in Section 7.3 of the DtL Priority Items report provided in Appendix A.

7. Monitoring

The recent Priority Item reporting supersedes some of the information in this Section of the Report. Therefore, this report must be read in conjunction with the Discharge to Land Priority Item reporting, Appendix A

Monitoring involves the collection and assessment of information relating to discharges from a RIS and associated environmental receptors. The recommended monitoring activities described for this RIS Standard ~~(in Sections 7.1.1 and 7.1.2 below)~~ focus on two aspects of the system:

1. System performance: Understanding performance, and collecting reliable information to enable proactive management
2. Receiving environment: Evaluating the effectiveness of any mitigation measures that have been implemented, and understanding the extent of any residual effects on the receiving environment (namely soils, groundwater, and surface water).

The intent in providing these recommendations is to establish a consistent minimum standard of monitoring for all publicly-operated RIS in New Zealand. This was identified as being necessary as a result of the review of existing consents (Section 3.2.3), where numerous inconsistencies in the type and frequency of monitoring being undertaken were noted. In the Discharge to Land Priority Item reporting, Appendix A this monitoring was split into the minimum monitoring required by the standards and then other monitoring which may be required by the SQEP based on the individual site conditions.

It is assumed that the monitoring requirements for a RIS will be determined during the design process, and prior to obtaining regulatory approval for the system. However, the monitoring programme should be adaptive, and frequently reviewed to ensure that it remains fit-for-purpose and is providing adequate information to achieve the level of understanding described above (i.e. for system performance and the receiving environment) (adapted from Section 8: Monitoring in (WasteMINZ 2023)).

Unless otherwise stated, soil and water samples shall be analysed by an International Accreditation New Zealand (IANZ) - certified laboratory provider. Receiving environment monitoring programmes should also consider (and follow, where applicable) the protocols set out in the National Environmental Monitoring Standards (New Zealand; available online at **https://www.nems.org.nz/documents**).

Note some of the information presented in the follow sections and tables has been superseded by Table 21, in Section 8.1 of the Discharge to Land Priority Item Report (Appendix A), which presents the minimum monitoring for compliance purposes. The sections below provided examples of additional monitoring that may be considered by the SQEP

7.1.1 System performance

The attributes described in Table 7.1 could be considered by a SQEP and monitored for operational reasons within a RIS.

Table 7.1 Potential operational and system monitoring requirements for a RIS - Note the minimum system monitoring requirements are outlined in Table 21, in Section 8.1 of the DtL Priority Items report provided in Appendix A.

System attribute	Description
Discharge rate / volume	– Continuous flow monitoring. – Flow meter installed on each soak hole, chamber or well (screened above water table).
Water levels	– Continuous water level monitoring of application events and infiltration with time at a minimum of one site (i.e. one basin) within the RIS system[1]. – Continuous water level monitoring within each well or similar structure[2]
General	For wells and bores, downhole bore inspection every 7 years to confirm integrity and any point of discharge (i.e. casing failure resulting in a discharge to ground other than through the well screen).

System attribute	Description
Treated wastewater quality (prior to application)	Monitor the following parameters in treated wastewater (prior to discharge into the RIS), with monitoring scheduled to align with receiving environment monitoring. All parameters listed should be analysed from discrete grab samples by an IANZ-certified laboratory (except where otherwise stated). – Dissolved oxygen (% saturation and mg/L) – in-situ only – Total Suspended Solids (mg/L) – 5-day carbonaceous Biochemical Oxygen Demand ($cBOD_5$; mg/L) – Total nitrogen (mg/L) – Total ammoniacal nitrogen (mg/L) – Total Kjeldahl Nitrogen (TKN) (mg/L) – Nitrate/nitrite N (mg/L) – Total phosphorus (mg/L) – Escherichia coli (*E.coli*; cfu/100mL) – Total faecal coliform (cfu/100mL) – Electrical Conductivity (in-situ and by lab) – Turbidity (in-situ only) – pH (in-situ only) Parameters that are monitored 'in-situ' could be analysed using real-time (or near-real time) continuous sensors (telemetry) or handheld meters.
[1] *Provides information on permeability and infiltration changes with time. Ideally linked to groundwater monitoring beneath the infiltration surface to provide a more complete understanding of system behaviour and environmental impacts.* [2] *Understand well performance over time.*	

7.1.2 Receiving environment

The following tables (Table 7.2, Table 7.3, and Table 7.4) describe the monitoring that could be undertaken in receiving environments..

Should monitoring identify detrimental effects on soil or water, a review of the RIS operation is to be undertaken. This review may include consideration of loading rates, area of application, groundwater flow direction and location of sensitive receptors. Recommendations from the review may require changes to the RIS including, for example, the establishment of contingencies (e.g. additional buffer storage capacity) that would have to be in place and triggered if effects are observed.

Table 7.2 ***Potential soil monitoring requirements for RIS - Note the minimum system monitoring requirements are outlined in Table 21, in Section 8.1 of the DtL Priority Items report provided in Appendix A.***

Soil monitoring	Requirements
Frequency	Pre-wastewater application (as part of Baseline and Site-Specific Assessments) Every 5 years thereafter.
Number of samples	Soil samples are to be collected at per hectare rate, determined by a Suitably Qualified Experienced Practitioner considering the treatment level, plant size and soil capability.
Parameters	– Phosphorus Retention Index (Pre- Wastewater Application Baseline /Site Specific Assessment only) – Cation Exchange Capacity (Pre- Wastewater Application Baseline /Site Specific Assessment only) – Sodium adsorption ratio (SAR) – Soil pH and EC – TKN – Ammoniacal N – Nitrate/nitrite N – Total phosphorus – Olsen phosphorus (Olsen P) – Other contaminants*

Soil monitoring	Requirements
~~The list of soil monitoring requirements is not exhaustive, and it is expected that the sampling frequency and parameters to be measured on each site would be finalised in the site's Management and Operation Plan. Additionally, analysis could include Carbon content /organic matter content, trace elements and field tests for ongoing permeability assessments.~~ ~~The results of the soil monitoring will be compared and reported alongside the treated wastewater results and groundwater monitoring results. These comparisons will help identify any potential issues and recommend remedial actions, if necessary, during the term of the consent or life cycle of the land application system. The temporal trends are more important than absolute values. Changes over time will be gradual, hence periodicity of 5 years is recommended.~~ ~~* Consideration of additional contaminants such as heavy metals and organics has been excluded by the scope, however, could be left to the discretion of the Suitably Qualified Experienced Practitioner~~	

Table 7.3 outlines the potential groundwater monitoring arrangements for all RIS. A SQEP will be required to determine what arrangements are most suited to the specific Site in question. w~~here the Standard applies. Noting that additional monitoring, including additional wells, may be required depending on site layout (in relation to groundwater flow) and location of sensitive receptors.~~

~~In addition, consideration should be given to 1) mapping of the groundwater impacted so Regional Councils can consider impacts for new consented takes and 2) bore censuses to track changes in groundwater users overtime.~~

Table 7.3 Potential groundwater monitoring requirements for RIS - Note the minimum system monitoring requirements are outlined in Table 21, in Section 8.1 of the DtL Priority Items report provided in Appendix A.

Attribute	Up gradient	Beneath[1]	Down gradient[2]
Number of monitoring bores[3, 4, 5]	Minimum 1 bore	Minimum 1 bore	Minimum 3 bore
Other (i.e. spring discharges)	To be considered for sites where these exist and taking account of factors such as connection to receiving surface water bodies.		
Groundwater level monitoring frequency	Continuous (logger)		
Water quality sampling frequency	At minimum quarterly		
Water quality parameters[6]	Chloride, Dissolved reactive phosphorus, *E. coli*, Electrical conductivity, pH, Total nitrogen, Total ammoniacal nitrogen, Nitrate nitrogen, TKN		

[1] Any groundwater monitoring directly beneath the infiltration surface (i.e, within a rapid infiltration bed). Well(s) should be screened across or close to the water table. Assists in understanding the level of treatment through the unsaturated zone and contaminant transport in groundwater from the point of entry through to down-gradient sites. It also allows for direct measurement of the water table fluctuations and unsaturated zone thickness beneath the discharge to better assess groundwater mounding and treatment potential. The water level data and response to application events will also provide information on any changes in soil / aquifer permeability overtime that might affect RIS system performance and resultant environmental impacts.

[2] May include sentinel bores with trigger levels up-gradient of sensitive receptors.

[3] Typically, a minimum of 3 bores is required to establish groundwater flow direction and monitor any changes in flow direction overtime Additional bores may be required to provide downgradient coverage if land disposal area is large or irregular shaped. Additional parameters may also be required at first, to establish the connections between the aquifers that the bores are targeting. i.e. making sure that the upgradient bore is in the same groundwater system as the downgradient bore, and not in a perched aquifer. These should be identified as part of the Site-Specific Assessment, when confirming that the Risk Category for the site is appropriate.

[4] Monitoring bores must be screened to intercept shallow water table aquifer, additional deeper bores may be required to intercept other aquifer layers depending on the geological setting and location of sensitive receptors

[5] Groundwater monitoring bores constructed in accordance with NZS4411:2001 – Environmental Standard for drilling of soil and rock.

[6] Groundwater sampling undertaken in accordance with the procedures outlined in National Environmental Monitoring Standards. Water Quality Part 1: Sampling, Measuring, Processing and Archiving of Discrete Groundwater Quality Data. March 2019. https://www.nems.org.nz/documents/water-quality-part-1-groundwater.

Table 7.4 outlines the possible surface monitoring requirements that may be useful is a site has a high probability of resulting in exceedance of human and aquatic ecosystem health standards and triggers. For example, this could be where there is a known connection between groundwater receiving discharges from a site, and a nearby surface water body. The adoption of any surface water monitoring will be advised by a SQEP

Table 7.4 ***Potential surface water monitoring requirements for RIS - Note the minimum system monitoring requirements are outlined in Table 21, in Section 8.1 of the DtL Priority Items report provided in Appendix A.***

Attribute	Upstream (control)	Within impact zone	Downstream
Water quality sampling frequency	At minimum quarterly, at locations upstream, within and downstream of the reach where the discharge is expected to enter the receiving water body		
Water quality parameters	TSS, Chloride, Total and Dissolved reactive phosphorus, E. coli (in freshwater; Enterococci in marine waters), total faecal coliforms, Electrical conductivity, pH (in situ only), Total nitrogen, Total ammoniacal nitrogen, TKN, Nitrate/nitrite nitrogen.		
Ecosystem health	– Dissolved oxygen (% saturation and mg/L), in-situ only – Ambient water temperature (°C) – in-situ only – Turbidity (NTU) – in-situ only – Periphyton (freshwater); Chlorophyll-α (marine waters)		

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8.1 Abbreviations and acronyms

Term	Definition
BOD	Biochemical Oxygen Demand
$cBOD_5$	5-day carbonaceous Biochemical Oxygen Demand
cfu	colony forming unit
DAR	Design Application Rate
DEFRA	Department for Environment Food and Rural Affairs
EcIA	Ecological Impact Assessment
E. coli	*Escherichia coli*
EPA	Environmental Protection Agency
IANZ	International Accreditation New Zealand
kg ha yr	kilograms per hectare per year
MAR	Managed Aquifer Recharge
MAV	Maximum Acceptable Value
MPCA	Minnesota Pollution Control Agency
RI	Rapid Infiltration
RIB	Rapid Infiltration Basin
RIS	Rapid Infiltration System
RIT	Risk Index Tool
RMA	Resource Management Act
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
WW	Wastewater
WWTP	Wastewater Treatment Plant

8.2 Glossary

Term	Definition
Aggregate Risk Level	A 1-4/scale classification system used to determine the overall level of risk associated with discharging wastewater to land, based on a risk screening that evaluates factors such as contaminant concentrations including E. coli, Total Nitrogen and Total Phosphorus, as well receptor sensitivity.
Aquifer Clogging	The reduction in permeability of an aquifer or its ability to transmit water, typically due to the accumulation of sediments or other materials within the pore spaces of the aquifer material
Application Method	The specific technique or approach used to apply a substance, treatment, or technology to a wastewater system. This includes the methods, equipment, and procedures employed to achieve the desired treatment or effect, ensuring efficiency, effectiveness, and compliance with relevant Standards. Application methodologies may vary depending on the treatment type, such as chemical addition, filtration, or biological processes, and are designed to optimize the removal or reduction of pollutants
Aquifer	A body of permeable rock or sediments (eg sand and gravel) which can contain or transmit groundwater
Baseline Assessment	An initial evaluation or desktop exercise conducted to identify and assess potential sites suitable for the application of treated wastewater. This assessment typically involves reviewing high level existing environmental, geological, and land use information to determine the suitability of land parcel for wastewater discharge, without the need for immediate site-specific assessment that would require fieldwork i.e. a first qualitative base for a proposed/potential site.
Border Dyke Systems	A series of shallow, parallel channels, known as 'borders' surrounded by low dykes to flood land.
Chemical Precipitation	Adding chemicals to convert dissolved substances into solid particles (precipitates) that can be removed through settling, filtration, or other methods.
Concentration	The measurement of the number of particles present in a given volume, often in a mixture or solution
Contaminant	Any substance (including heavy metals, organic compounds and micro-organisms) that, either by itself or in combination with other substances, when discharged onto or into land or water, changes or is likely to change the physical, chemical or biological condition of that land or water. [RMA Definition].
Diffuse discharge	A non-point source discharge, i.e., not introduced from a specific outlet
Down gradient	Refers to the direction in which groundwater flows, dictated by the hydraulic gradient of aquifer. Down gradient is the groundwater on the "downstream" side relative to a specific area or point of reference (i.e. land discharge area)
Effluent	Wastewater discharge following some level of treatment, i.e., primary or secondary treatment.
Exposure Pathway	The route by which a receptor is exposed to a hazard
Groundwater	Water found underground in the cracks and spaces in soil, sand and rock
Hazards	Anything that has the potential to cause harm, damage, or adverse effects), such as E. coli, TP, and TN, which pose public health, stock health, or environmental risks.
High-Rate Application (rate)	The discharge of wastewater to shallow basins constructed in permeable deposits of highly porous soils, 6 to 90 m / year. (Adapted from Wastewater Technology Fact Sheet - Rapid Infiltration Land Treatment, USEPA 2003).
Ion exchange	Physical-chemical process in which ions are swapped between a solution phase and a solid resin phase. Source: **EPA Effluent Limitations Guidelines (ELG) Glossary**
Land application system	The system used to apply effluent from a wastewater treatment unit into or onto the soil for further in-soil treatment and absorption or evaporation (as per AS/NZS 1547:2012).
Land contact	term used to describe wastewater systems where the treated wastewater contacts some land before being discharged to surface or marine waters.

Term	Definition
Loading Rate Numerical Matrix	A tool used to determine the appropriate class of Standards for wastewater discharge, combining Risk Category and Site Capability Categories.
Low-rate application (rate)	The controlled application of treated wastewater to a vegetated soil surface, where wastewater receives treatment as it flows through the plan root / soil matrix.
Mass Loading	The quantity of a particular substance or pollutant that is introduced into a wastewater system over a specified period, typically expressed in units of mass per time (i.e., kilograms per day or pounds per day). Source: United States Environmental Protection Agency (EPA). "Wastewater Treatment Plant Operation and Maintenance Manual."
Pathogens	Disease-causing micro-organisms such as certain bacteria, viruses and parasites.
Pathways	refer to the routes through which contaminants from the discharged wastewater move or are transported to receptors. Examples include surface runoff, infiltration into the soil, or leaching into groundwater, that enable the exposure of receptors to the pollutants.
Physical Straining	A preliminary wastewater treatment method used to remove large, solid debris and suspended particles.
Primary treatment	The separation of suspended material from wastewater in septic tanks, primary settling chambers, or other structures, before effluent discharge to either a secondary treatment process, or to a land application system (as per AS/NZS 1547:2012).
Receptors	A component of the natural that is affected by the construction and/or the operation of a proposed development, in this instance, disposal of wastewater to land. This includes those potentially affected by the hazards and associated qualifying criteria, which are site-specific and need to be identified.
Risk	An expression of the likelihood of identified hazards causing harm in exposed populations or receiving environments, and the severity of the consequence (risk = likelihood x consequence); as per AS/NZS 1547:2012.
Risk Matrix	A tool used in risk management to categorise and prioritise risks based on their likelihood and impact.
Risk Screening	the process of evaluating potential risks associated with discharging (treated) wastewater to land. The screening process is intended to determine the likelihood and severity/consequences of various risks including contamination of soil/land parcels and or groundwater, impacts on public health. The goal of risk screening approach is to prioritise areas or scenarios that require site specific assessment, helping asset managers to inform decision-making and ensure that appropriate management and operation measures are implemented.
Secondary treatment	Minimum level of treatment required prior to application to RIS, which has been interpreted to include the use of waste stabilisation ponds.
Site Capability	the suitability of a specific land parcel location to receive discharge of (treated) wastewater based on its physical, environmental, and ecological characteristics. Site capability takes into account factors like soil properties, topography, hydrology, hydrogeology, climate, and land use, and is used to assess whether the site can safely and effectively handle wastewater application without causing harm to the environment, public health, or surrounding receptors.
Site Capability Category	A level of between one to five applied to represent either the degree of Risk or the Site Capability of a site being considered for land application of treated wastewater.
Site-Specific Assessment:	A detailed evaluation process conducted at a particular location to assess the potential risks and impacts of discharging (treated) wastewater to land. The assessment considers local parameters such as topography, geology, soil type, hydrology, climate, land use, and receptor sensitivity.
Soil type(s):	Refers to the classification of soil (treatment unit) based on their physical characteristics, including texture, composition, and structure. These characteristics influence how the soil treatment unit behaves with regard to wastewater or land application in terms of water retention, drainage, fertility, and its ability to support plant growth.

Term	Definition
Sorption	A treatment technology by which a physical, chemical, or combined physical-chemical adsorption or absorption process, using a resin or other media such as granular activated carbon. Source: **EPA Effluent Limitations Guidelines (ELG) Glossary**
Standard Class	A group of numerical limits, part of the Standards
The Standard(s)	The entire approach to regulation of discharges of treated wastewater to land, to be established under the Local Government (Water Services) Act. Includes the risk-based approach and proposed numerical limits described in this report.
Total Nitrogen	The total amount of nitrogen in wastewater (including organic and inorganic nitrogen)
Total Phosphorus	The total amount of phosphorus in wastewater (including organic and inorganic phosphorus)
Unsaturated Zone	The portion of the subsurface above the groundwater table. The soil and rock in this zone contains air as well as water in the pores. Source: **USGS Groundwater Information**.

Appendices

Appendix A

Discharge to Land Priority Items Report 2025

Report – Final

19 September 2025

To	Marcus Bishop, Strategic and Technical Advisor, Taumata Arowai	Contact	Justine Bennett
Copy to	Donna Caddie, Simone Palmer, Sara McFall, Michael Petherick	Email	Justine.Bennett@ghd.com
From	GHD, Beca & Stantec Consultant Team	Project No.	12669824
Project Name	Technical Advice on WW Discharge Standards - Phase 2		
Subject	Responding to request for additional advice on priority items relating to the Discharge to Land Standard		

Dear Marcus,

1. Introduction

The Water Services Authority – Taumata Arowai (herein referred to as Taumata Arowai), under its statutory authority conferred by the Water Services Act 2021, is developing National Wastewater Environmental Performance Standards (The Standards) that will apply to new or renewed resource consents for publicly operated wastewater treatment plants (WWTPs). Consistent with the proposed legislation amendments announced by the Minister of Local Government in August 2024, principally revisions of the Water Services Act 2021, the Resource Management Act 1991, and the Local Government (Water Services) Bill, the proposed changes seek to implement "a single Standard rather than a minimum (or maximum), which would be implemented in resource consents".

The Government's rationale for these amendments is the need to:

- Provide directive provisions that ensure regional councils implement a single Standard approach in resource consents and cannot set additional or higher requirements than the Standard in consenting conditions (apart from on an 'exceptions' basis).
- Allow Taumata Arowai to set infrastructure and operating requirements that, if implemented by a wastewater operator, will meet the treatment requirements in the Standard.
- Allow an easier resource consenting path or 'pre-consented option' for lower-risk small-scale modular wastewater treatment plants that meet the wastewater environmental performance Standard.
- The proposed new approach intends to meet the following objectives of Taumata Arowai:
  - Reduce the regulatory burden by ensuring environmental regulation in water services legislation is proportionate to risk and benefit.
  - Deliver much greater standardisation of treatment systems and related infrastructure.
  - Enable material cost efficiencies in the design, build and operation of wastewater systems.
  - Provide councils with greater certainty of costs.

In line with this policy directive, Taumata Arowai engaged Ernst & Young Strategy and Transactions Limited (EY) and Tonkin & Taylor Ltd (T+T) in early 2024 to undertake a Performance Standards Options Assessment for wastewater discharges to land and discharge to water. The Assessments produced initial environmental performance standards. Feedback received from the Technical Review Group, convened by Taumata Arowai to review and provide advice on the draft Standards, highlighted the need for further technical advice and assurance that the proposed Discharge to Land and Discharge to Water Standards (which are the two components that make the National Wastewater Environmental Performance Standard) were coherent and practical approaches to consenting of WWTPs.

To undertake this assessment and progress work on the Discharge to Land Standard and Discharge to Water Standard, Taumata Arowai engaged GHD, Stantec and Beca to provide technical advice on specific matters. The additional technical advice was provided in two reports in early 2025 and published on the Taumata Arowai Website[1]. Subsequently a third report was produced in July 2025 by GHD, Stantec and Beca providing additional technical advice on the Discharge to Land Standard regarding Rapid Infiltration Systems (RIS).

Following public consultation on the Discharge to Land Standard and the Discharge to Water Standards, a wide suite of feedback was provided to Taumata Arowai. The feedback was consolidated into themes and ultimately 'Priority Items' that required further consideration. GHD, Stantec and Beca were engaged again to provide additional advice regarding the Priority Items.

1.1 Scope of work

The current scope of work is therefore to provide further advice on the Priority Items associated with the Discharge to Land and Discharge to Water Standards. This scope has been separated into two parts: one focused on the Discharge to Land Standard Priority Items, and another focused on the Discharge to Water Priority Items. This scope is addressing the Discharge to Land Standard Priority Items.

The Priority Items associated with the Discharge to Land Standard have been provided to GHD, Stantec and Beca by Taumata Arowai, and this scope of work has provided technical advice in response to each item. It is understood Taumata Arowai will consider this technical advice, and where it is considered appropriate, incorporate the advice and any proposed updates into the Discharge to Land Standard.

1.2 Purpose of this report

The purpose of this short form report is to:

– Provide technical advice in response to the provided Priority Items, to support the further development of the Discharge to Land Standard (herein referred to as the Standard).
– Provide information that Taumata Arowai can use to further inform an Order in Council and summarise the rationale for the conclusions reached regarding the Priority Items.

This report should be read in conjunction with the Technical Advice on Discharge to Land Standards report, previously prepared for Taumata Arowai[1].

1.3 Limitations

This report: has been prepared by GHD, and subconsultant Beca and Stantec, for Taumata Arowai and may only be used and relied on by Taumata Arowai for the purpose agreed between GHD and Taumata Arowai as set out in section 1 of this report.

GHD and it's subconsultants otherwise disclaims responsibility to any person other than Taumata Arowai arising in connection with this report. GHD and it's subconsultants also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD and it's subconsultants in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD and it's subconsultants have no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD and it's subconsultants described in this report (refer to section 1.4, and throughout this report). GHD and it's subconsultants disclaim liability arising from any of the assumptions being incorrect.

GHD and its' subconsultants have not been involved in the development of the Order in Council prepared separately by Taumata Arowai and has had no direct contribution to the Order in Council other than in the development of this report for the purpose as stated in Section 1. GHD and its' subconsultants exclude and disclaim all liability for all claims, expenses, losses,

[1] **12656252_GHD_REP - Technical Advice on Discharge to Water Standards - REV0.docx** and **12656252_GHD_REP - Technical Advice on Discharge to Water Standards - REV0.docx**

damages and costs, including indirect, incidental or consequential loss, arising directly or indirectly in connection with the Order in Council.

GHD and it's subconsultants have prepared this report on the basis of information provided by Taumata Arowai and others who provided information to GHD (including Government Authorities), which GHD and it's subconsultants have not independently verified or checked beyond the agreed scope of work. GHD and it's subconsultants do not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

Accessibility of documents

If this report is required to be accessible in any other format, this can be provided by GHD and it's subconsultants upon request and at an additional cost if necessary.

1.4 Assumptions and Exclusions

The following assumptions have been made when providing advice on the Priority Items relating to the Discharge to Land Standards which makes up this document:

– The Priority Items provided by Taumata Arowai are a consolidation of feedback obtained through numerous submissions on the Discharge to Land Standard. The individual submissions have not been reviewed by the Consultant team. Taumata Arowai have provided additional information where relevant.
– Taumata Arowai will provide any response to submissions as they deem appropriate. It is assumed the advice provided in this document will be utilised to inform their response to submissions, the Order of Council and any amendments to the Standard. The advice provided for each priority item is not intended to be directly used as a response to submissions.
– Iwi perspectives on the Priority Items will continue to be addressed separately by Taumata Arowai.
– The intent of the National Wastewater Environmental Performance Standards is to protect against a variety of potential effects in the receiving environment; to adequately protect public health and to enable the maintenance or improvement of receiving environment condition.
– Under current RMA requirements, consent renewals are considered "de novo" which means that the application for a renewal is considered as if it is a new consent application. It has been assumed that this practice will continue. The assessments undertaken in this report have assumed that any consents issued for treated wastewater discharges will include treatment requirements or other conditions set out in the wastewater standards.

The following exclusions apply to this scope of work:

– Specific response to submissions has not been provided.
– Advice on implementation of the Standard and interaction with other legislative requirements is not provided.
– Specific detailed documentation on how to implement the Standard at a design and operational level has not been developed as part of this scope of work. High level guidance has on Operations and Managements Plans has been provided, within this scope, as documented in Section 7.
– Updates to the Standard, or previously provided technical advice reports, is not included in this scope, rather this scope provides additional information to be considered by Taumata Arowai in further progressing the Standards.

Please note, content in this report supersedes some information presented in the Technical Advice on Discharge to Land Standards Report (dated February 2025) and the draft Technical Advice on Discharge Standards – Rapid Infiltration Report (dated July 2025). The reader should be familiar with these reports prior to reading this report.

2. Priority Items

The Priority Items provided by Taumata Arowai, which are to be addressed in this report, are summarised in Table 1. Each item is specifically addressed in the following subsections.

Table 1 Summary of Priority Items for Discharge to Land Standards and agreed approach.

Item	Item Description	Agreed approach to address Item
12. Dual schemes	Taumata Arowai require advice on how the standards should apply to dual discharge schemes (those that discharge to water for only some of the year, and discharge to land for the remainder). The starting point for the approach should be the proposal made by Manawatu District Council.	– Review Manawatu proposal to assess suitability vs proposed approach in Discharge to Water technical Report. Taumata Arowai to provide submission content as soon as possible. – Confirm any exclusions – Document options and recommended approach – Workshop with Taumata Arowai – Update documentation
13. Baseline Assessment	The technical report indicates the baseline assessment will be an area dealt with in guidance. The Authority intends to work with the Land Treatment Collective to develop this guidance. We require advice on the core areas that should be dealt with in this guidance, so we can commission this work in a way that ensures consistency with the overall scheme for the discharge to land standard.	– Review material in Discharge to Land technical Report and the Rapid Infiltration Deliverable – Summarise key matters to be include in an assessment at Order of Council level (and hence to be covered by guidance document). – Provide supporting reference list
14. Site Specific risk assessment and treatment / loading matrix	The Authority requires further technical advice in a number of areas relating to the site-specific risk assessment and treatment / loading matrix that will apply. Our suggestion is this area is best initially scoped through a workshop with key technical advisers to identify areas where advice has already been provided, and areas that require further work. We have identified the following areas: – Confirm site capability assessment and categories – Confirm risk screening assessment and categories – Confirm weighting of assessments to identify category for treatment / loading – Confirm whether / how applicant can apply mitigation measures to change site capability or risk assessment – The technical report states that where there is public access, different pathogen limits apply – integrate this approach into framework. The technical team has requested whether detailed information can be sourced about consented concentrations, flow that is applied to the land and disposal areas. The Authority will identify examples in	– Review site capability assessment table in Discharge to Land Technical Report update as required. – Confirm weightings if any that apply to category for treatment or loading rate. – Confirm mitigation and provide list of potential measures for mitigation. – Integrate pathogen limit for public access. – Was previously identified as further work (i.e., out of scope for DtL) so not previously completed to required level of detail. Work will require development of risk screening assessment process and very high-level guidance on variables to reduce subjectivity. Will be based on approach adopted for rapid infiltration (in progress), likely based on ISO 310000. Need to identify hazards, risk factors and consequence tables and explanatory text. – Workshop with Taumata Arowai to refine.

Item	Item Description	Agreed approach to address Item
	submissions, consider whether there are particular councils we could approach, or identify contacts at Land Treatment Collective.	
15. Application categories and limits	Some submissions said that the loading rate for TN and TP under class 1 was too high. Taumata Arowai require review of loading rates to ensure they are appropriate as part of the overall treatment framework. Some submissions said there should be more classes of categories for treatment / loading rates than is currently proposed (a small number apply to a large range of situations). Taumata Arowai require advice on whether there are the appropriate number of categories.	– Review proposals in submissions to be provided by Taumata Arowai Review consent applications to derive TN/TP loading rates and adjust or provide explanation as necessary. – Review number of categories defined across Discharge to Land and RIS. Advise if more are required.
16. Operations and management plan	Taumata Arowai require advice on the areas that an operations and management plan must include as part of a consent (minimum requirements). Please also consider if are there other areas the Authority require advice on in this area as part of standards.	– Summarise key matters to be included at Order of Council level (and hence to be covered by guidance document). – Provide supporting reference(s). Likely USEPA and similar NZ guidance.
17. Monitoring requirements	Taumata Arowai require final advice on the monitoring requirements (groundwater and soil) that will apply as part of discharge to land standard based on advice in technical report, and confirmation of how these will link to an O&M Plan.	– Summarise key matters to be included at Order of Council level (and hence to be covered by guidance document). – Provide supporting reference(s) Likely USEPA and similar NZ guidance.
18. Exclusions	Exclusions (situations where the discharge to land standard should not apply) are set out in the technical report and Taumata Arowai do not require any further advice at this stage. We will review submissions against these exclusions and come back to you if further advice is required.	The consultant team will be producing more exclusions for the Rapid Infiltration workstream, so we suggest a meeting to discuss exclusions on a whole with Taumata Arowai (2 hours for 3 people).

3. Dual Schemes (item 12)

This section provides responses to Priority Item 12, as outlined in Table 2. The following sections present comments and recommended actions.

Table 2 Priority Item 12 for Discharge to Land Standards

Item	Description (from Taumata Arowai)	Proposed approach
12. Dual schemes	Taumata Arowai require advice on how the standards should apply to dual discharge schemes (those that discharge to water for only some of the year, and discharge to land for the remainder). The starting point for the approach should be the proposal made by Manawatu District Council.	– Review Manawatu proposal to assess suitability vs proposed approach in Discharge to Water technical Report. Taumata Arowai to provide submission content as soon as possible. – Confirm any exclusions – Document options and recommended approach – Workshop with Taumata Arowai – Update documentation

3.1 The Issue

Dual schemes (also known as ‘mix and match’) are widely regarded as a good approach to managing effluent discharges and are used in a lot of areas across Aotearoa New Zealand. The general approach resolves several technical issues associated with both Discharge to Water (DtW) and Discharge to Land (DtL) schemes where receiving environment options may be constrained or suboptimal. For example, a discharge to land may be preferred during dry periods that coincide with low baseflow in freshwater receiving environments, or warmer (and lower dissolved oxygen) in coastal/estuarine receiving environments. Conversely, discharge to water may be preferred when the land capability is not optimal to receive the additional discharge (e.g. where groundwater is too shallow, soil moisture content is too high and cannot assimilate extra discharge).

The intent of the dual scheme approach is therefore to enable schemes to operate where receiving environment conditions are suitable and appropriate to receive the discharge, and to allow the operator flexibility to select the most appropriate discharge regime based on site specific carrying capacity to accommodate the discharge.

There is a need to reflect the intent of the dual scheme framework clearly in the Standards, and also to reflect the intent that a pathway to obtain a 35-year consent via the Standards is achievable using the dual scheme approach. The projected treated wastewater flows and loads and any variation in the receiving environment for the 35 year consent period will still be required to assess the envelope of effects for the dual scheme approach, as is required under a single receiving environment scheme.

3.2 Submission on Standard

Taumata Arowai provided excerpts of submissions from two parties. Key matters raised in the submissions, with respect to dual discharges management, were:

– The methodology for calculating the DtW dilution ratio assumes that there are no alternative discharge methods and does not take into account the benefits of a dual discharge regime on the receiving environment.

– The standards need to be flexible enough to enable treatment plants to operate a dual discharge regime that minimises discharges to water during low-flow periods:

  - Ensure that the dilution calculations for discharges to water are adaptable to account for reducing volume. For example, if the low flow data are excluded for that period of time when discharges from the plant are to land (i.e. over summer), this increases the dilution ratio to fit well within the “low” dilution ratio.

- This would result in improved environmental and cultural outcomes through encouraging dual discharge regimes and preventing river discharges where possible.

– Storage options may be considered to optimise when wastewater is discharged to freshwater or coastal water (i.e. under higher flows that can more readily assimilate discharges when unable to discharge to land).

– Operators should specify the dilution ratio that they are going to operate under and demonstrate that 90% of the days over a five-year period are within that range. This would shift the standards to focus on actual effects rather than predicted effects (over the ‘uncertainty’ of a 35-year consent period).

The regime as described in the Manawatu District Council (MDC) submission provides a good example of how a dual scheme can be operated based on real-time information. However, the methodology described cannot be used directly to assess the status of the discharges over the 35-year term of the potential consent and hence determine the DtW category or DtL class. The DtW category and DtL class requires the predicted wastewater flow and receiving environment conditions assessment, as given in the proposed Standards.

3.3 Assumptions and linkages for dual schemes

The key assumption for implementation of dual schemes is that the operator adopts an appropriate discharge quality and regime that meets the requirements of DtW and DtL (slow and rapid infiltration) standards, but that the standards are selected and applied on the basis of the physical conditions during the intended discharge period only. Thus, assessments under DtW/DtL require bespoke evaluations, based on site specific conditions, for the discharge period to enable appropriate treatment class/standards to be applied.

As with the DtW and DtL Standards, a suitably qualified and experienced practitioner (SQEP)[2] will be required to inform and/or oversee the appropriate technical expertise for assessments required under each Standard.

3.4 Examples of existing dual schemes

Three example wastewater schemes were identified which operate dual schemes. Details of the consent conditions are provided in Attachment 1, at the end of Section 3. Attachment 1 is a summary of the information available from the consents for each scheme. In summary, the schemes include:

– Hawea: the discharge is balanced between two DtL systems; one being a land treatment scheme which uses spray irrigation, and the other a soakage trench. There are limits on the volume of wastewater that can be sent to each system, either separately or combined. The use of the irrigation scheme in winter months is not allowed, and the balance of the load between the two systems has to be determined annually.

– Fielding: which is the Manawatu District Council system was the subject of their submission. This balances the discharge between the DtL and DtW based on the wastewater and river flows and soil moisture which are all measured in real time. The consent requires the prediction and recording of nutrient budgets on an annual basis throughout the consent.

– Blenheim: includes DtL by spray and drip irrigation and a DtW which is to the Wairau Estuary. The DtL is constrained to a nitrogen load of 200kgN/Ha/yr and is only allowed to discharge in deficit irrigation and when the depth to groundwater is more than 0.3 m. The DtW is generally restricted to the outgoing tide only and has maximum volume restrictions.

For the Fielding Scheme, it is noted that the limits set out in Horizons Regional Council ‘One Plan’ has been a key driver for the establishment of dual schemes in the region. This has been a step taken to reduce discharge to surface water to avoid adverse effects to periphyton for hard bottom streams.

There are no specific requirements in the consents to maximise the use of the DtL scheme over the DtW scheme. This requirement could be usefully added to recommended consent conditions.

[2] The definition for a SQEP will need to be defined in supporting Guidance documentation. There is no formal definition of a SQEP in New Zealand legislative documents, however the Users’ Guide: NES for Assessing and Managing Contaminants in Soil to Protect Human Health 17, does provided some guidance on what skills and background a SQEP may need to meet. The guidance indicates they should be independent, apply good professional practice, and reports against relevant industry guidelines. The practitioner should essentially be an expert in some specific and relevant fields and experienced in drawing together multidisciplinary inputs and drawing conclusions. A SQEP should be willing to certify that the content of the information and report(s) they have developed complies with good practice and professional standards, and to stand by the conclusions of the report. For example, a person certifying a report should be someone who could ultimately stand in the Environment Court and provide expert testimony, and whose experience and qualifications stand up to Court scrutiny.

These schemes and their associated consent conditions demonstrate how dual schemes have been consented and operated to date.

3.5 Conceptualisation

3.5.1 Conceptual Framework

The general process for assessing Dual Scheme operations is described below.

- Baseline assessment – this is required for both DtL & DtW component. The applicant will need to have a good level of confidence that the proposed dual discharge regime will provide a discharge pathway under all reasonably foreseeable combinations of receiving environment conditions (e.g. river flow for DtW and groundwater level/soil saturation conditions for DtL). Potential climate change impacts need to be considered over the 35 year consent period.
- For each DtW/DtL component, the respective discharge standards / treatment class defined in either the DtW or DtL or RIS reports apply for the receiving environment conditions during the discharge period only (i.e. not for the whole year). For example, determined by flow for freshwater and site capability for land discharge.
- For each DtW/DtL component, the treated wastewater flows will be determined for the conditions when each route is intended to be used. For example, for DtW which will only occur in winter, the design median flow to calculate the Dilution Ratio would be determined, excluding the summer period. For DtL (which is only to be conducted in summer), higher winter treated wastewater flows would be excluded from the derivation of flows used to determine the conceptual size of the application area[3] and for expected compliance with the specified DtL Class nutrient loading rate limits (noting this will also be determined by the Site Capability Category Assessment requirements).
- For freshwater receiving environments, the dilution ratio to determine the receiving environment category and hence treatment limits will be calculated using an adjusted 'Mean 7-day Low Flow[4] (calculated as the mean of the 7-day low flow condition during the period of discharge only[4]. It is also noted that, in theory, more than one adjusted Mean 7-day Low Flow and hence treatment limits can apply. In practice, a treatment process could be designed and operated to give the required concentration at the worst-case conditions during the period of discharge[5].
- For marine environments, a "river flow" is not relevant to the determination of the receiving environment category. This determination is primarily related to location and hence would not change from that applied to a DtW only schemes. CORMIX modelling is to be used to confirm the relevant category. The treated wastewater flow to be used could be determined and aligned to the conditions during which discharge to the coastal waters is envisaged.
- For DtL, both Site Capability Category and Risk Level could be assessed for the expected conditions during the period of discharge only. The parts of the assessments most likely to be changed by the use of a dual scheme are: hydraulic connectivity, particularly depth to GW; soil moisture conditions; and potentially, likelihood of risk events occurring. Nutrient uptake will also be a key consideration (as per the Site Capability Assessment process) and will be used to inform the Aggregated Risk assessment for DtL.
- The dilution ratio for the discharge (for DtW) and the site capability category/risk level for the discharge conditions (for DtL) then determine the Standards that will apply for each route.
- Assessments for both DtW and DtL discharge regimes will require the knowledge of a SQEP to oversee/ inform all appropriate requirements under DtW Standards as well as DtL Standards for the preferred discharge regime. This includes responsibility for ensuring the correct technical expertise / input for different components (either doing themselves or ensuring the right technical people are being engaged / right technical inputs are included appropriately)

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[3] A general definition for application area is provided in Section 6.5, refer to Table 18.
[4] It is noted here, the conventional Mean Annual Low Flow (MALF) does not strictly apply, as the full hydrological year (July to June) is not applicable for the statistical calculation. It is expected that the Guidance Document will include further details on the minimum time period to inform the hydraulic analysis on which to base the adjusted Mean 7-day Low Flow calculation
[5] It is expected that the Guidance Document will provide further direction on whether the relative discharge flow over the period of discharge to land, will also be required. For example, this may be based on the Annual Dry Weather Flow, or a similar comparable statistic to support the assessments.

- Using a SQEP de-risks the element of someone performing the assessments, without the appropriate technical experience or knowledge to understand the ramifications of the discharge regime being put in place or of restrictions being implemented etc.
- Consent conditions will need to specify the expected physical conditions for the required discharge regime for both DtW and DtL components[6].
- Approach to dual discharge is intended to be a balanced approach that enables smaller operators and those constrained by physical environmental conditions, to operate with flexibility in order to optimise community and environmental outcomes.
- A dual discharge may require a performance feedback loop by which a discharge regime may need to be iteratively adjusted to ensure treatment standards are complied with. Suggested consent conditions for this assessment could be developed in guidance material.
- As part of assessments for dual discharge schemes, there needs to be consideration and development of appropriate contingency plans to accommodate long periods of wet weather, low flows etc that lie outside the assumed envelope of operating conditions.

3.5.2 Information Required

As per the DtW Standards, the operator will require appropriate flow/hydrodynamic information to inform the process for calculating appropriate dilution ratios, and thus identification of treatment standards or allowable discharge flows. Where possible, empirical flow data should be used to calculate the appropriate Mean 7-Day Low Flow statistic (based on appropriate minimum data requirements, to be detailed in the proposed Guidance Document).

The appropriate level of information will need to be guided by a SQEP and may result in the requirement to obtain additional data to robustly inform the required dilution ratios to be applied to the DtW regime. Where appropriate flow/hydrodynamic information is not available, this will need to be obtained. This may be available from the latest version of the Ministry for the Environment 'River Flow' geospatial data[7].

If an appropriate flow record for a surface freshwater receiving environment is not available, additional site-specific flow gauging may be required to inform river flow conditions. At a minimum, three consecutive years' flow record would be required to robustly inform site specific trends (the method to obtain this data would depend on location and operator requirements, but for example, can include the use of continuous water level loggers retrieved periodically to obtain data). Similarly, a verified synthetic flow record or modelled flow information may be able to inform the envelope of effects for a 35-year application. In the absence or inability of the operator to obtain appropriate flow data, an alternative pathway to identifying the adjusted dilution ratio for the dual scheme may be required, which for example may be based on receiving environment (upstream and downstream) monitoring to demonstrate the required dilution ratio that could be achieved for the flow regime.

The SQEP will also need to guide how potential climate change impacts over the 35 year consent period are factored in the assessment of Dual Discharge schemes, including in terms of discharge period and Mean 7-day low flow calculations. Longer periods of low flow in rivers/streams may require greater reliance on the DtL scheme, whereas longer wet periods or more frequent extreme rainfall events may require less reliance on DtL scheme. Conversely, Mean 7-day Low Flow may be over-estimated if longer periods of low rainfall become common in the future, depending on timing of discharge to water.

Post consenting, the operator will require ongoing data to inform appropriate dilution ratios and when discharge regimes can be switched from DtW to DtL (and vice versa). For example, this may be in the form of real-time flow monitoring, or a suitable alternative for smaller schemes.

3.5.3 Requirement for a Guidance Document

On the basis of the information described in Section 3.5.1 and 3.5.2, a Guidance Document will be useful to:

- Describe information requirements for consenting.

[6] Physical conditions of respective DtW/DtL receiving environments are highly correlated with seasonal timeframes. The consent conditions may reflect this, but the intent is to not restrict the dual scheme on the basis of calendar definitions, rather it is determined by the physical conditions (and key constraints) of the receiving environment receiving the discharge.
[7] **River flows | MfE Data Service**

- Describe DtW/DtL requirements for informing the iterative process.
- Describe the requirements for any bespoke statistical calculations required to:
  - Establish the minimum time period to inform the hydraulic analysis on which to base the adjusted Mean 7-day Low Flow calculation.
  - Establish multiple Mean 7-day Low Flow statistics.
- Describe information requirements for post-consent monitoring (operational and receiving environment monitoring).
- Describe roles and responsibilities of a SQEP to inform the steps above.

3.6 Recommendations for Order of Council

It is recommended that dual scheme discharges are enabled through the DtW and DtL Standards, and that the relevant Standards (and associated technical assessments) are applied for the conditions during the period of discharge only.

It is recommended that the envelope of effects for the 35-year consent period is retained to inform potential future effects.

Supporting advice notes:

- A suitably qualified and experienced practitioner (SQEP) will be required to undertake the appropriate DtW and DtL technical assessments, in accordance with the requirements in those Standards, to inform appropriate treatment standards/classes for the intended discharge volume and duration.
- The requirement to provide and maintain appropriate real time measuring equipment or a suitable alternative for smaller schemes is expected to be included as a consent condition.
- Assessments and discharge regimes can include multiple scenarios and can be iterative, with the intent that the flexibility provides for optimal receiving environment protection.
- A Guidance Document setting out the framework will be useful to inform operators on development and implementation of the process to incorporate DtL and DtW standards according to site specific requirements.

Attachment 1: Consent Conditions for Dual Schemes

Name of Scheme	Description of Scheme	Relevant Consents	Consent Constraints for DtW	Consent Constraints for DtL
Hawea – Medium WWTP – High Dilution Category	Facultative pond; MBBR to Spray irrigation to: – Land Treatment Area (LTA); or – a soakage trench to Hawea River	DtL that may enter water (2 routes by same consent) Granted in 2023 for 10 yrs	No direct discharge to water	Size: – LTA must be 2.33Ha and various controls on design and management – Trench must be 150m x 2m, using low pressure pipe with 7mm holes To LTA: – No discharge over June/ July/ August – 4 day max volume of 932 m^3/4 days – Annual ave of 233 m^3/day – Max rate of 40 mm/day to land Over both routes: – max combined flow of 1,000 m^3/day – max load of 4,726 kg/yr Conc limits: – Amm-N: mean 20 mgN/L – TN: mean 35 mg/L – TP: mean 10 mgP/L – E.coli: mean 250,000 cfu/100ml Calculate the load balance between 2 routes on annual basis, and between applied and removed by Cut & Carry (C&C)
Fielding (MDC scheme in submission) – Medium WWTP – Low Dilution Category	Activated sludge; treatment ponds; UV; to – Irrigation; or – to drain entering Oroua River	All granted in 2016 DtL for 35 yrs: – one for discharge to land and – one for discharge to GW resulting from irrigation to land DtW for 10 yrs	Flow: – until DtL starts, max TWW flow of 12,000 m^3/day when river <half median flow or 25,000 m^3/day at higher river flow – once DtL starts, – annual med of 9,500 m^3/day and max of 25,000 m^3/day – if river > half median flow, then DtW when dilution ratio (DR) > 50:1 – if river < half median flow, then DtW when DR > 50:1 and storage ponds filled to 80% OR (if cannot comply with 106950) at 95% capacity regardless of DR.	Size: Area as given in consent Operation: – Drip line, or supply details for a spray irrigation system for certification by RC – C&C – Cut-off drains and buffer management plan – Irrigation only when soil infiltration is >7mm/day when SMC halfway between FC and Sat – Other operational controls – Submit actual and predicted annual nutrient budget Flow: max 9,800 m^3/day Conc limit: – E.coli: max 1,000 cfu/100mL

Name of Scheme	Description of Scheme	Relevant Consents	Consent Constraints for DtW	Consent Constraints for DtL
			– This regime requires continuous monitoring of TWW and river flow – 3 x consents based on different TWW flow rates. (7400, 8499, 9500 m^3/day) Conc limits: – $cBOD_5$: median 5mg/l – TSS: median 10mg/l – SIN: median 15, 12.5, 10 mgN/l for increasing TWW flows and 95%ile 40 mgN/L – DRP: median 0.1 mgP/l and 95%ile 1, 0.75, 0.5 mgP/L for increasing TWW flows – E.coli: median 50, 95%ile 1,000 cfu/100mL River limits after reasonable mixing (for S107 and nutrient effects)	– Monitor typical and salts conc while TWW applied to land.
Blenheim – Large WWTP – Estuary	Ponds and Constructed wetland to – Spray irrigation, with drip irrigation around edges; or – Wairau Estuary via a constructed wetland	DtL and Coastal permit granted in 2010 for 15 yrs	Flow: ave 28,500 m^3/day, max of 103,680 m^3/day Discharge restricted to outgoing tide, except after prolonged rain event when storage of ponds/wetland is exceeded TWW Conc limits: – Amm-N: median 15, 90%ile 20mgN/l – FC: median 350, 90%ile 1,075 cfu/100mL River effects conditions (temp/colour/clarity/DO) and monitoring required	Load limit: TN: 200kgN/Ha/yr and 50 kgN/month/Ha Same Conc limits as DtW TWW only applied: – using deficit irrigation regime (depth of TWW applied not exceed soil moisture deficit) – when GW more than 0.3m from ground surface Various buffer controls Spray irrigation to cease is wind speed > 15 km/hr towards adjacent boundary GW level monitoring at least fortnightly

4. Baseline Assessment (Item 13)

This section provides responses to Priority Item 13, as outlined in Table 3. The following sections present comments and recommended actions.

Table 3 Priority Item 13 for Discharge to Land Standards

Item	Description (from Taumata Arowai)	Proposed approach
13. Baseline Assessment	The technical report indicates the baseline assessment will be an area dealt with in guidance. The Authority intends to work with the Land Treatment Collective to develop this guidance. We require advice on the core areas that should be dealt with in this guidance, so we can commission this work in a way that ensures consistency with the overall scheme for the discharge to land standard.	– Review material in Discharge to Land technical Report and the Rapid Infiltration Deliverable – Summarise key matters to be included in an assessment at Order of Council level (and hence to be covered by guidance document) – Provide supporting reference list

4.1 Basis of Recommendations

A baseline assessment should be undertaken to provide a preliminary assessment of a location's suitability for the application of treated wastewater to land, either slow rate or rapid infiltration. It is generally carried out as a desktop study while determining the best practicable option for the discharge. It may include one site or several sites.

The purpose of the baseline investigation is to increase knowledge of the site/s, its limitations, and any fatal flaws. It begins an iterative process, and the baseline assessment will be further developed in subsequent phases of investigation should a land application system at a site be pursued.

Recommendations for the items within the baseline assessment are based on available literature and professional experience. Key references (report links embedded)[8] used to develop the baseline assessment requirements included:

– **Design Manual, Land Treatment of Municipal Wastewater Effluents**
– **New Zealand Guidelines for Utilisation of Sewage Effluent on Land**
– **Wastewater Discharge to Land, Good Practice Guide**

4.2 Recommendations

As indicated in Table 3, the baseline assessment requirements will be detailed in guidance accompanying the Discharge to Land Standard. The baseline assessment is to be completed as a desktop feasibility assessment on a prospective land parcel including, but not limited to, investigating where relevant for the land parcel:

– Site physical attributes (i.e., soils, slope, topography).
– Underlying geology (characteristic of the unsaturated zone where treated wastewater will flow before it reaches the water table (groundwater) and consideration of drainage impediments).
– Available groundwater data (aquifer type, depth to water table, perched groundwater, quality and temporal trends, redox conditions, flow direction (vertical and horizontal), flow velocity, seasonal and event variation, groundwater recharge, groundwater abstractions, springs, connection to surface water).

[8] - Design manual, land treatment of municipal wastewater effluents: **Document Display | NEPIS | US EPA**
- New Zealand Guidelines for Utilisation of Sewage Effluent on Land: **https://www.lei.co.nz/images/custom/resources/nzltc-guidelines-pt1.pdf**
- Wastewater Discharge to Land, Good Practice Guide: **https://www.fndc.govt.nz/__data/assets/pdf_file/0014/16133/2022-wastewater-discharge-to-land-guidance-document-beca.pdf**

– A preliminary estimate of the groundwater hydraulic properties (hydraulic conductivity, transmissivity, aquifer thickness, specific yield, heterogeneity).
– Hydrology (i.e., water sources and abstraction, flow regime, quality and trends and connection to groundwater).
– Climate data (total annual and probability of extreme rainfall events) particularly focused for areas with frequent intense rainfall and potential evapotranspiration.
– Available soil data (i.e., types, infiltration rate, texture, drainage capacity and attributes, profile available water, heterogeneity, nitrogen and phosphorus leaching potential, Phosphate retention (from regional and national maps, i.e. S-map).
– A preliminary estimate of the soil moisture and the percentage of days per year it will exceed field capacity, in its baseline state and subsequently with treated wastewater application. Required key element for slow rate (SR), optional (dependent on proposed system type) for RIS.
– Initial estimate of the treated wastewater application area[9] required based on hydraulic loading, plus an allowance for conservatism as well as associated ancillary area required for RIS (i.e., space available for the system, allowing for rest periods, expansion, buffer zones, reserve area, access roads or paths).
– Identify potential receptors, proximity and sensitivity (including environmental, human / social, cultural, built environment). Consideration should be given to immediate and ultimate receiving environments and should identify adequate buffer zones to reduce off site impacts.
– Site contamination history.
– Current and proposed land use within potential application area (consider ownership), including whether the land will be accessed by the public.
– Feasibility of utilising the land productively to reduce nutrient leaching, i.e., cut and carry (not applicable for RIS).
– Natural hazards[10] such as flood-prone land and instability, and future climate risk (e.g. sea level rise).
– Existing environmental pressures in the catchment (i.e., existing state and potential for cumulative effects on the receiving environment).
– Desktop groundwater assessment on available empirical and literature data sources (i.e., soil moisture sampling, any previous groundwater sampling, modelling or reporting to determine magnitude of groundwater mounding).
– Review of relevant local council plans, policies and rules, (i.e. nutrient allocation, cultural heritage sites, significant ecological areas, natural wetlands).
– Existing monitoring and compliance records (for existing DtL system or site), which may signal an existing site is not working well and likely to be releasing nutrients or pathogens to receptors.

The assessment should be completed by a SQEP and the results of the investigation reviewed by key stakeholders and relevant professionals. Any significant gaps in technical information should be identified and rectified to inform the subsequent Site Capability and Risk Assessment processes. The SQEP will also need to guide how potential climate change impacts over the 35-year consent period are factored in the baseline assessment. For existing DtL systems, much of the required information to inform the risk and site capability assessments will be already available. Where existing monitoring data (groundwater or surface water) are available, these can be used in place or alongside models to provide more certainty in the assessment.

[9] This is defined as the **site** for the purposes of calculating TN and TP annual loading rates. Where the **site** is the total land area over which treated wastewater is directly applied. The **site** is essentially the wetted area of the DtL system, including setback distances between irrigators, driplines, trenches, beds etc. The **site** excludes land area where treated wastewater is not directly applied on a routine basis, such as buffer distances (e.g. to sensitive receivers), DtL reserve area, WWTP and associated areas (e.g. access roads).
[10] During baseline assessment, Regional and District plans will need to be checked for restrictions regarding social, cultural and ecological requirements. In addition, they should be checked for natural hazards, i.e., sites with an unacceptable risk will have already been excluded (e.g. flood-prone land). However, these plans and maps can be confirmed during natural hazard categorisation assessment.

5. Site Specific Risk Assessment and Treatment Matrix (Item 14)

This section provides responses to Priority Item 14, as outlined in Table 4. The following sections present comments and recommended actions.

Table 4 Priority Item 14 for Discharge to Land Standards

Item	Description (from Taumata Arowai)	Proposed approach
14. Site Specific risk assessment and treatment / loading matrix	The Authority requires further technical advice in a number of areas relating to the site-specific risk assessment and treatment / loading matrix that will apply. Our suggestion is this area is best initially scoped through a workshop with key technical advisers to identify areas where advice has already been provided, and areas that require further work. We have identified the following areas: – Confirm site capability assessment and categories – Confirm risk screening assessment and categories – Confirm weighting of assessments to identify category for treatment / loading – Confirm whether / how applicant can apply mitigation measures to change site capability or risk assessment – The technical report states that where there is public access, different pathogen limits apply – integrate this approach into framework. The technical team has requested whether detailed information can be sourced about consented concentrations, flow that is applied to the land and disposal areas. The Authority will identify examples in submissions, consider whether there are particular councils we could approach, or identify contacts at Land Treatment Collective.	– Review site capability assessment table in Discharge to Land Technical Report update as required. – Confirm weightings if any that apply to category for treatment or loading rate – Confirm mitigation and provide list of potential measures for mitigation – Integrate pathogen limit for public access – Was previously identified as further work (i.e., out of scope for DtL) so not previously completed to required level of detail. Work will require development of risk screening assessment process and very high-level guidance on variables to reduce subjectivity. Will be based on approach adopted for rapid infiltration (in progress), likely based on ISO 310000. Need to identify hazards, risk factors and consequence tables and explanatory text. – Workshop with Taumata Arowai to refine.

5.1 Issues and context

The Discharge to land (DtL) Standards identified Rapid Infiltration Systems (RIS) as a relatively low-cost and 'compact' solution for land application that is widely implemented throughout New Zealand. However, due to the fundamental differences in design and operation (for RIS) compared with slow rate irrigation (SRI) systems, it was necessary to develop the RIS Standards separately to the SRI approach.

In terms of the overall approach, however, the need for alignment and greater consistency across the Risk Assessment Framework has been identified. The Draft Rapid Infiltration Systems (RIS) (July 2025 Draft Report) adopts the International Standard for Risk Management – Guidelines (Second edition, 2018-02; ISO 31000). This has been identified as the preferred approach to align both the SRI and RIS frameworks, as it is an approach that the majority of experienced practitioners in the wastewater industry (both in New Zealand and globally) will be familiar with. Therefore, it can be adapted as required to suit a project's needs as well as those of the regulators (regional councils) and Taumata Arowai.

The purpose of this advice is to recommend alignment across the SRI and RIS approach to risk assessment. That is, the recommendations apply to the DtL Standards as a whole.

As noted in the SRI and RIS technical documents, the DtL Standards apply only to total nitrogen (TN), total phosphorus (TP), and the faecal indicator bacteria *E. coli*. Other contaminants of concern will be managed outside of the DtL Standards.

5.2 Risk assessment process and alignments

A common approach to the risk assessment process is proposed across RIS and SRI for the DtL Standard that aligns with the Risk Assessment Framework presented in the draft RIS report.

An overview of the recommended Risk Assessment Framework for the DtL Standard is shown schematically in Figure 1. As noted in Figure 1 (and set out in both the RIS and SRI reports), the Baseline Assessment is required to be undertaken as a desktop feasibility study on a prospective land parcel, prior to progressing to subsequent steps in the Risk Assessment Framework. It is anticipated that the Baseline Assessment requirements will be detailed in guidance accompanying the Standards. As noted in the RIS/SRI reports, sites with an unacceptable risk (e.g. a natural hazards such as flood prone land etc, as identified on Regional and District plans) will likely be excluded during the baseline assessment stage.

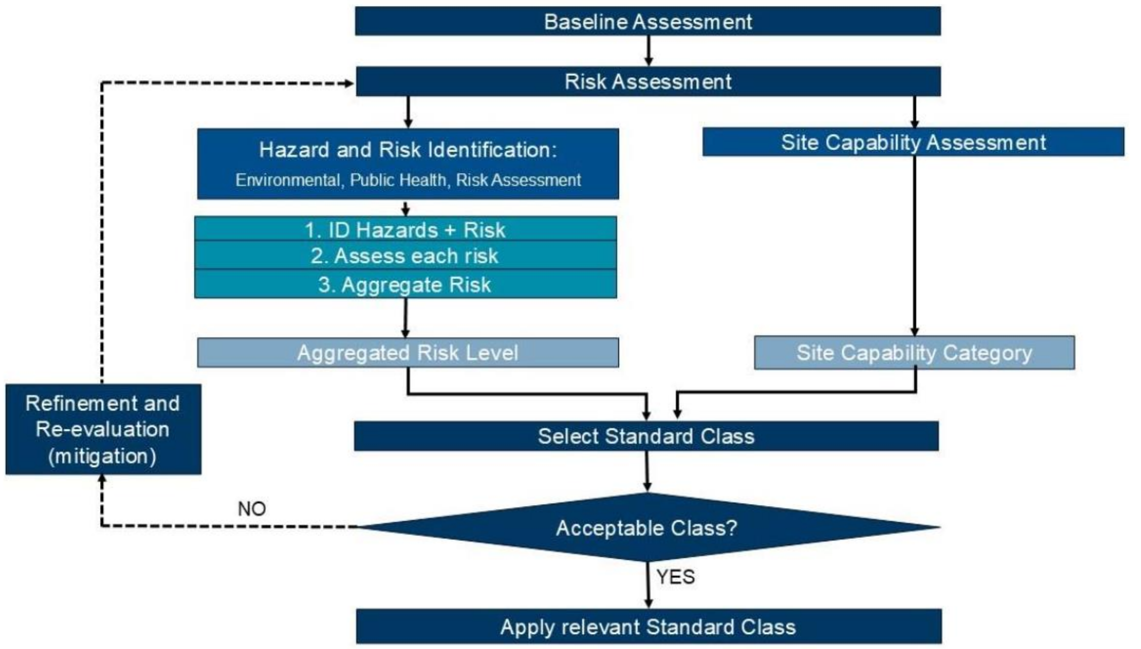

Figure 1 Schematic of Risk-based process for Iterative process for Discharge to Land assessment (Figure 4.1 in RIS report)

The Risk Assessment Framework is described in the draft RIS report and not repeated in this document. This section steps through the framework for the DtL Standard (i.e. both SRI and RIS) and recommends amendments to the following aspects of the framework in the draft RIS report:

– Table 4.1 (Minimum Risk/Hazards)
– Table 4.2 (Likelihood definition)
– Table 4.4 (Risk Level Matrix)
– Table 4.6 (Aggregated Risk).

No changes are proposed to Figure 4.1 (schematic of the risk-based approach under framework), Table 4.3 (Consequence) or Table 4.7 (Matrix for selection of applicable Standard Class) in the draft RIS report for the DtL Standard (i.e. SRI and RIS).

It is noted that the concepts of Site Capability Category and Standard Class apply across the DtL Standard. However, there are different requirements for RIS and SRI. Requirements for RIS are presented in the draft RIS report, with the Site Capability Assessment table for RIS repeated in Section 5.3 of this report for completeness. Requirements for SRI are presented in the Discharge to Land Priority Item Report (this report). Relevant background material is provided in the Discharge to Land Report (February 2025). However, key aspects with respect to matters for the Order in Council have been superseded by this Report.

Risk assessments carried out under the DtL Standard should be undertaken by a SQEP and will typically require input from a range of practice areas (i.e. multiple SQEPs).

5.2.1 Identify hazards and risks

The first step in the Risk Assessment Framework for the DtL Standard is to identify specific risks for each hazard type. Table 5 identifies the recommended amendment to the current Table 4.1 in the draft RIS report for the DtL Standard (i.e. for both SRI and RIS). Specifically, to remove the lines 1, 2 and 7, shown as strike-through text below, and addition of one line, shown in italics below. Removing the three lines does not alter any of the risk categories in the remaining table items. This is because the risk to groundwater and surface water are accounted for in the immediate lines below and requirement to consider existing monitoring and compliance records has been included in the baseline assessment. The additional item is to ensure the risks associated with different levels of public access to a land application site, and hence, potential exposure pathways are adequately considered by the SQEP.

Table 5 Minimum hazards and associated risks that need to be considered (Recommended amendments to RIS Table 4.1)

Hazard Type	Risk
Environmental	~~Contamination of groundwater compromising the potential future use~~
	~~Contamination of Surface Water~~
	Release of toxicants ammonia and nitrate to groundwater or surface water, such that acute effects occur.
	Release of Nitrogen, Phosphorus leading to eutrophication
	Buildup of Phosphorous in soils which compromises current or future use of the site
	Mobilisation of existing contaminants such as Nitrogen and Phosphorous where the catchment is already at or close to Regional Catchment Nutrient Budget
	~~Existing monitoring and compliance record signals that the site is not working well and likely to be releasing nutrients or pathogens to receptors~~
Public Health	Drinking water protection zone is compromised leading to public health warning due to nitrate, pathogens or viruses[1]
	Domestic private drinking water bore is compromised leading to public health notice due to nitrate, pathogens or viruses
	Release of indicator organisms to a level that causes exceedance of contact recreation guidelines Illness due to contact recreation
	Level of public access to land application site and hence exposure to indicator organisms, including exposure to aerosols transmitted within and from site
	Mobilisation of existing contaminants such as Nitrogen and P where these are already elevated at or close to MAV.
[1]MfE 2018 Technical Guidelines for Drinking Water Source Protection Zones	

5.2.2 Assess each risk

The next step in the Risk Assessment Framework for the DtL Standard is to assess each risk in terms of likelihood and consequence of occurrence and then determine the individual risk levels from a Risk Matrix. It is recommended that the approach for assessing likelihood is modified for the DtL Standard (i.e. for both SRI and RIS), as presented in this section. The approach for assessing consequence remains unchanged from the draft RIS report (see Table 4.3, in the RIS report, and Table 7 below). Given the amendment to the approach for assessing likelihood, the Risk level matrix must also be modified (refer to Table 8 below, which replaces Table 4.4 in the RIS report).

For assessing likelihood, Table 6 identifies the recommended amendment to Table 4.2 in the draft RIS report for the DtL Standard (i.e. for both SRI and RIS). The Likelihood rating of 'Never' was added to recognise that where a risk may be initially identified, the pathway to the receptor has been blocked/disrupted to reduce/take away any exposure. The percentage of likely occurrence was also removed to provide for clearer application of the definition for both Public Health and Environment Risk by the SQEP(s) carrying out the assessment, and to acknowledge a percentage scale is not directly transferable between the two receptor groups.

Table 6 Definitions of likelihood ratings (Recommended amendment to RIS Table 4.2)

Likelihood rating	Definition
Almost certain	Is expected to occur in most circumstances
Likely	Will probably occur in most circumstances
Possible	Could occur
Unlikely	Could occur but not expected
Rare	Occurs but only in exceptional circumstances
Never	Is not expected to occur in any circumstances

Table 7 Definitions of consequence ratings (RIS Table 4.3 – not changed from RIS report)

Consequence rating	Definition – Public Health	Definition – Environmental
Insignificant	Illness resulting from the treated wastewater discharge is indiscernible above the normal background level of illness in the community.	Small scale pollution or other environmental damage is localised with no resultant effects. Any changes in environmental condition are not discernible from baseline. Contained locally. None related to the discharge
Minor	Health effects are limited to a single person, single household or single group of people. Any persons affected experience a minor illness (e.g. minor gastrointestinal illness)	Minimum pollution or other environmental damage. Minor shift away from existing baseline conditions. Short-term effects only
Moderate	Health effects affect a larger group of people across a wider area, any persons affected experience a minor illness (e.g. minor gastrointestinal illness).	Repeated departure from existing baseline conditions with discernible adverse effect at localised level. Effects over medium term.
Major	Health effects affect a larger group of people across a wider area. Persons affected experience a moderate illness (e.g. norovirus, where hospitalisation may be required), which may be dangerous to sensitive members of the community.	Significant and widespread pollution or other environmental damage, major departure from existing baseline conditions with long-term effects (but these effects could still be remedied).
Extreme	Health effects affect a larger group of people across a wider area. Persons affected experience a major illness, which is likely to be dangerous to sensitive members of the community.	Permanent (irreversible) alteration to baseline condition with fundamental changes to the aquatic ecosystem.

Table 8 Risk Level Matrix (Recommended amendment to RIS Table 4.4)

		Consequence				
		Insignificant	**Minor**	**Moderate**	**Severe**	**Extreme**
Likelihood	**Almost Certain**	Low	Medium	High	Critical	Critical
	Likely	Low	Medium	High	Critical	Critical
	Possible	Low	Medium	Medium	High	Critical
	Unlikely	Low	Low	Medium	Medium	High
	Rare	Low	Low	Low	Low	High
	Never	NA[1]	NA[1]	NA[1]	NA[1]	NA[1]

Notes:
[1] NA – not applicable. Under the scenario of a risk having no likelihood of occurrence (i.e. a likelihood rating of 'never'), there will be no consequence. Any risks that have a likelihood rating of 'never' will not be considered when determining the Aggregated Risk Level.

5.2.3 Aggregate risk

The next step in the Risk Assessment framework for the DtL Standard is to aggregate the individual risks levels assigned to each of the hazards/risks assessed. For assigning the Aggregated Risk Level, Table 9 sets out the recommended amendment to Table 4.6 in the draft RIS report for the DtL Standard (i.e., for both SRI and RIS). An approach that further considers individual risks is recommended over a pooled percentage approach. Under the revised approach, where any single risk is identified as 'critical', it represents a significant issue for the overall performance of the DtL system and results in a Risk Level 4 (highest risk level) being assigned. Because of the potential for health-related effects or environmental harm based on the risks listed in Table 5, this is considered an appropriate approach.

Table 9 Criteria for assigning Aggregated Risk Level (Recommended amendment to RIS Table 4.6)

Aggregated Risk Level	Critical	High	Medium	Low
Risk Level 1 (lowest)	None	None	None	All risks at this level
Risk Level 2	None	None	Single risk at this level	NR[1]
Risk Level 3	None	Single risk at this level	2 or more risks at this level	NR[1]
Risk Level 4 (highest)	Any risk at this level	2 or more risks at this level	NR[1]	NR[1]

Notes:
[1] NR – not required for assessing Risk Level. One or more risks can be at this level.

5.3 Site capability

In this stage for the DtL Standard, the capability of the site to accept, treat and transport the treated wastewater in a manner that meets appropriate receiving environmental and public health performance requirements is assessed.

Table 10 presents factors that must be considered at a minimum as part of the Site Capability Assessment for SRI. The table replaces the one in Section 2.14.1 of the Discharge to Land (SRI) Technical Report, with refined description and deletion of the final line (natural hazards) as it is now covered under the Baseline Assessment. The Site Capability Assessment for RIS is presented in Table 4.5 in the draft RIS report and presented below in Table 11 for completeness.

For all new DtL systems (i.e. both SRI and RIS), the overall Site Capability Category for a site is the highest (i.e. most precautionary) Site Capability Category based on all factors considered under the worst-case scenario. Where there is a shared description between site capability categories for a given factor (e.g. slope), the least restrictive applies.

For existing DtL systems (i.e. both SRI and RIS), the Site Capability Category is undertaken as an 'on balance' or 'weight of evidence' approach, to be inclusive of all existing monitoring data and based on SQEP judgement. The SQEP will also need to guide how potential climate change impacts over the 35-year consent period are factored in the site capability assessment.

Generally, suitability for slow rate irrigation decreases with ascending category. At some sites, an attribute may vary over the site. For example, drainage over parts of the site may be Category 1 and other parts may be Category 2 and/or Category 3. In addition, the categories for some factors may be common and others different. For example, a site may be Category 1 for soil drainage and soil texture yet Category 3 for proposed land use. Selecting a single site capability for determining, along with Risk level, the Standard Class keeps the DtL standards simple to use and monitor and would fit most situations. Different parts of a larger discharge to land site could potentially have areas with significantly different risks or site capability factors. There is no particular concern with being able to treat these areas separately and having different standard classes applicable for defined areas within a discharge to land area under a single consent.

If the site capability assessment concludes a Category 5 (unsuitable) ranking and mitigations cannot be applied to reduce the ranking (see Section 5.5), then the DtL standards do not apply.

The reasons for the changes to the site capability assessment factors for SRI are outlined below:

– Drainage – S-map categories have been adopted. In addition, drainage impediments in the underlying vadose have been included to be consistent with the RIS standard and allows the use of the available information in S-map. The top 1m of the soil is where the majority of the wastewater treatment occurs.
– Soil Type and Suitability - No changes proposed.
– Climate and soil moisture regime – this factor is critical in understanding the hydraulic assimilative capacity and treatment performance of the soil. The table has been aligned to the USEPA 2006 provisions, which analyses soil moisture balance using climatic data and irrigation regimes.
– Proposed land use – a clearer definition of this factor has been proposed based on now much nitrogen is likely to be removed via the vegetation/crop cover on the site (based on published information). Nutrient uptake via crops/vegetation is required to provide a more moderate net loading consistent with equivalent farming operations (e.g. fertiliser or FDE application). TP uptake is expected to follow a similar pattern to TN with the additional reduction via soil adsorption.
– Topography/Slope – no changes have been proposed. A number of current discharges to land systems operate successfully on slopes and risks associated with run-off would input into the risk level assessment. A requirement for very low slopes for Site Capability category 1 would reduce the flexibility of operators to develop sloped areas that could operate effectively with buffers or other mitigation measures.
– Depth to groundwater – a less conservative approach has been proposed consistent with the USEPA 2006 process design manual. This avoids double counting of groundwater risks.

Table 10 Updated Site Capability Assessment for SRI.

Factor	Category 1	Category 2	Category 3	Category 4	Category 5
Drainage S-map class >1 m depth *Note 1*	Well drained Free of any drainage impediment in Vadose zone	Moderately well drained Free of any drainage impediment in Vadose zone	Imperfectly drained Free of any drainage impediment in Vadose zone	Poorly drained Minor drainage impediments in Vadose zone	Very poorly drained Extensive drainage impediments in Vadose zone
Soil Type and Suitability *Note 2*	Fine sand, loamy sand Sandy loam, loam, silt loam	Fine sand, loamy sand Sandy loam, loam, silt loam	Fine grained – clay loam, silty clay loam	Course granular soil	Light or heavy clays, peat soils
Climate & soil moisture regime *Note 3*	Site soil remains below field capacity year-round with irrigation	Irrigation brings the site soil above field capacity, but soil never reaches field saturation	Irrigation occasionally brings site soil to field saturation in winter period at which point irrigation ceases.	Site soil occasionally reaches field saturation in winter period without irrigation	Site soil reaches soil saturation for prolonged periods in winter, without irrigation.
Proposed Land use *Note 4*	Significant nutrient uptake from pasture/crops >400 kgN/ha/yr e.g. cut and carry	Significant uptake from pasture/crops >400 kgN/ha/yr e.g. cut and carry	Moderate nutrient uptake from crops/ permanent vegetation cover >100 kgN/ha/yr e.g grazed pasture, sports fields and golf courses	Limited nutrient uptake from crops or permanent vegetation cover <100 kgN/ha/yr e.g. harvested trees	Limited nutrient uptake from vegetation cover
Topography Slope *Note 5*	Low relief < 10-degree slopes	Low relief < 10-degree slopes	Slopes up to 17 degrees	Slopes up to 17 degrees.	Slopes > 17 degrees
Depth to Groundwater *Note 6*	Shallowest depth to GWL (including groundwater mounding) >5 m	Shallowest depth to GWL (including groundwater mounding) >3 m	Shallowest depth to GWL (including groundwater mounding) between 3 and 1.5 m	Shallowest depth to GWL (including groundwater mounding) between 1.0 and 1.5 m.	Shallowest depth to GWL <1.0 m
~~Natural hazards (e.g. flooding, land instability)[5]~~	~~Negligible risk~~	~~Low risk~~	~~Medium risk~~	~~High risk~~	~~Very High risk~~

Notes:

1. Reference: Landcare **Soil drainage » New Zealand Soils Portal - Manaaki Whenua - Landcare Research**. Drainage category may vary over a site. Site drainage mapping is needed for design development.
2. Reference: Soil texture - AS/NZS 1547: 2012; other suitability factors (see Landcare) to investigate may include phosphorus retention, susceptibility to nitrogen leaching, susceptibility to bypass flow. Soil texture category may vary over a site.
3. Reference: USEPA 2006. Typically, a site should not be irrigated during a rainfall event. Wastewater operational storage may be required.

Factor	Category 1	Category 2	Category 3	Category 4	Category 5
4. Reference: Various. Other sources of nitrogen (e.g. fertilizer, stock) and total area over which nitrogen budgeting is applied need taking into account; Land use in addition to the irrigation area will include separation distances to property boundaries, surface waters and drainage paths, and sensitive cultural and ecological sites. 5. Reference: AS/NZS1547:2012. Other matters to consider include surface water run-off paths, site aspect, and shape. 6. Reference: USEPA 2006					

Table 11 Site Capability Category Criteria for RIS. (RIS Table 4.5)

Factor	Category 1 *(Ideal)*	Category 2 *(Minor limitations)*	Category 3 *(Limitations)*	Category 4 *(Marginal)*	Category 5 *(Unsuitable)*	Technical basis
Drainage	Very well drained. Free of any drainage impediment in Vadose Zone.	Well drained. Free of any drainage impediment in Vadose Zone.	Moderately well drained. Free of any drainage impediment in Vadose Zone.	Imperfectly drained.	Poorly drained.	Adapted from Landcare S-map. and ASNZ/1547
Soil type	Well graded sands and sandy gravel; gravel cobbles (with limited silt/clay <10%); pumice.	Fine sand; loamy sand; sandy loam	Clay loam; silty clay loam with adequate structural development	Heavy textured clays and silty clays with limited structural development.	High risk soils (heavy clay, peat, water repellent soil)	Adapted from a range of references including (Milne, Clayden, Singleton, & Wilson, 1995), (USEPA, 2006) and ASNZ/1547.
Slope	Flat	Low relief <5°	5 - 10°	10 - 15°	>15° unless feasible to regrade.	(Chakir, Lekhlif, Sinan, & Maki, 2023) state that slopes for RIS, a basin construction must not exceed 15%. Sites containing a slope of 0%–5% are most appropriate.
Depth to Groundwater	Shallowest depth to GWL (including groundwater mounding) >5 m	Shallowest depth to GWL (including groundwater mounding) >3 m	Shallowest depth to GWL (including groundwater mounding) between 3 and 1.5 m	Shallowest depth to GWL (including groundwater mounding) between 1.0 and 1.5 m.	Shallowest depth to GWL <1.0 m	Unsaturated zone thickness from (USEPA 2006) Table 1.2, for SAT: Cat 4: 3 m to 1.5 m during drying Cat 5: < 1 m during an application event; < 1.5 m during drying. Unsaturated zone thickness greater than the US EPA standard of 3 m allows for greater pathogen removal.

Notes:

1. Soil suitability should consider the capacity to assimilate wastewater, including physical characteristics such as permeability, water holding capacity, structure and texture as well as physico-chemical and biological considerations such as Phosphorus Retention Index, soil pH, organic matter content and exchangeable cations.
2. Regional and District Plans will be checked during the Baseline Assessment i.e. sites with an unacceptable risk will have already been excluded (e.g. flood-prone land). However, these plans and maps can be confirmed during natural hazard categorisation assessment.
3. Sufficient land should be available to accommodate land application of wastewater, separation distances to property boundaries and surface waters, a reserved area (if required by designer), and sensitive cultural and ecological site
4. For all sites consider climatic conditions including rainfall, temperature (freezing) and extreme events.
5. Reference: USEPA 2006
6. Consideration should have been given during the Baseline Assessment to nationally or regionally significant social, cultural, or ecological areas.
7. The minimum unsaturated zone factors account for groundwater mounding.

5.4 Select Standard Class

The approach for determining the Standard Class to be applied to the site from the Aggregated Risk Level and Site Capability Category for the DtL Standard (i.e., both SRI and RIS) remains unchanged from the draft RIS report (see Section 4.2.4). The matrix for selecting the applicable Standard Class is presented in Table 4.7 in the draft RIS report and presented below in Table 12 for completeness.

If the outcome is not acceptable (for example, the applicable Standard Class is not financially feasible, or is considered too stringent to achieve with the treatment system available), then the risk assessment is re-iterated to account for mitigation measures, design and operational considerations, and/or weightings for different types of risk (to be determined in consultation with stakeholders and the regulatory authority). For SRI this process is further described in Section 5.5 below. For RIS, this process is further described in Section 4.3 of the draft RIS report.

Table 12 Matrix for selection of applicable Standard Class (RIS Table 4.7).

		Site Capability			
		Category 1	**Category 2**	**Category 3**	**Category 4**
Risk	**Level 1**	Class 1 loading rates apply	Class 1 loading rates apply	Class 2 loading rates apply	Class 3 loading rates apply
	Level 2	Class 1 loading rates apply	Class 2 loading rates apply	Class 2 loading rates apply	Class 3 loading rates apply
	Level 3	Class 2 loading rates apply	Class 2 loading rates apply	Class 2 loading rates apply	Class 3 loading rates apply
	Level 4	Class 2 loading rates apply	Class 2 loading rates apply	Class 3 loading rates apply	**Standards cannot be applied[1]**

Notes:
Standards cannot be applied to Site Capability Category 5 regardless of risk level, unless mitigations can be applied to reduce the Site Capability Category ranking.

5.5 Refinement and Re-evaluation (Mitigation)

The process for optimising a Wastewater Discharge to Land Scheme design generally requires consideration of both risks and site capability features. The process is iterative until a suitable solution is found. Both the risk and site capability assessments are to be done for the conditions under which the discharge happens (i.e. not during conditions where there is no discharge due to storage or alternative discharge to water).

For the risk assessment process, common mitigation options considered to reduce either risk likelihood or consequence include:

- Buffers to waterways, wetlands, neighbouring properties, boundaries
- Restricting public and livestock access to discharge location or stand-down period following discharge
- Operational practices like shutdown during high winds
- Changes to application depths and frequencies to reduce groundwater mounding
- Changes to treated wastewater quality e.g. reduction in pathogens or nutrients
- Provision of alternative water supplies to adjacent or impacted bore water users
- Changes to application technology e.g. to reduce/avoid aerosols or more suitable for steeper slopes

For the site capability assessment, the mitigation options considered are more limited as the site is usually selected, but could include:

– Exclusion of areas of the site with less suitable soil types or slopes
– Changes to application depth and frequency to avoid soil saturation
– Storage to reduce/avoid application when groundwater levels are high or soils are saturated
– Choice of crop to suit required nutrient removal regime
– Consideration of dual discharge regime if appropriate (e.g. discharge to water when soil or groundwater conditions are unsuitable for land discharge)

5.6 Pathogen limits for public access

5.6.1 Background

The table in Section 2.16 of the Discharge to Land (SRI) Technical Report presented proposed indicator organism concentration limits (as *E. coli*) for each Standard Class. No *E. coli* limit was proposed for Class 1, assuming the pathway/receptor connection could be adequately removed. *E. coli* limits of <2,000 cfu/100mL and <1,000 cfu/100mL were proposed for Class 2 and 3, respectively, where sites have restrictions on public access. For Class 2, it was also proposed that no *E. coli* limit also be considered where the pathway/receptor connection could be adequately removed (i.e. as for Class 1). The *E. coli* limits where pathway/receptor connection is removed, or public access is restricted are being reviewed under a different priority item (i.e. Item 15) and not considered further here.

For unrestricted public access, such as a golf course, the proposed numeric limit for *E. coli* was <1 cfu/100mL for all Standard Classes. The limit and associated commentary were provided in a note to the table of proposed numeric limits in the Technical Report. The *E. coli* limit related to this '**unrestricted public access'** is being reviewed under this priority item (i.e. item 14) for SRI systems only; 'unrestricted public access' is not considered appropriate for RIS systems.

In terms of public health risk, the potential level of exposure to treated wastewater applied to land via a SRI system is influenced by several factors, including:

– SRI discharge mechanism used, e.g. spray irrigation, surface or subsurface irrigation
– Use of restricted watering times, e.g. night-time watering
– Setback distance from residential or public access areas
– Use of fencing and/or signage to restrict site access.

5.6.2 Relevant guidelines

Relevant guidelines are summarised in Table 13.

Table 13 Relevant guidelines

Reference	Use of Wastewater	Wastewater Quality	On-site Mitigation
New Zealand Guidelines for Utilisation of Sewage Effluent Land (2000)[11]	Category 1 – Irrigation of salad crops, fruit and other crops for human consumption, which may be eaten unpeeled and uncooked	<10 faecal coliforms /100mL (secondary treatment with disinfection)	No harvesting crops when wet with irrigated water
	Category II – irrigation of public amenities e.g. sports fields, public parks golf course, playgrounds. Irrigation of crops	<200 faecal coliforms / 100mL (secondary treatment with disinfection)	No public access while land is being irrigated.

[11] Table A.4.1 in: Excerpt from "Public Health Guidelines for the Safe Use of Sewage Effluent and Sewage Sludge on Land" (Chapters 4, 8 and selected tables), Department of Health 1992. As reproduced in New Zealand Land Treatment Collective and Forest Research, New Zealand Guidelines for Utilisation of Sewage Effluent Land – Part Two: Issues for Design and Management, 2000.

Reference	Use of Wastewater	Wastewater Quality	On-site Mitigation
	for human consumption which will be peeled or cooked before being eaten	<1000 faecal coliforms /100mL (secondary treatment with disinfection)	Grass surface or sprayed area must be allowed to dry out thoroughly after irrigation (48 hours or longer as necessary) before public allowed
		No quality restrictions (secondary treatment with disinfection)	Public amenities only. Subsurface irrigation system which prevents sewage effluent reaching the ground surface.
Australian Guidelines for Water Recycling (2006)[12]	Municipal uses – open spaces, sports grounds, golf courses, dust suppression or unrestricted access and application	*E. coli* <1 cfu/100mL (advanced treatment)	No specific measures
	Municipal uses – with restricted access and application	*E. coli* <100 cfu/100mL (secondary treatment with disinfection)	Restrict public access during irrigation and one of no access after until dry, minimum 25-30m buffer, or spray drift control
	Municipal uses – enhanced restrictions on access and application	*E. coli* <1,000 cfu/100mL (secondary treatment)	Restrict public access during irrigation and combinations of no access after until dry, minimum 25-30m buffer, or spray drift control
Victorian Guideline for water recycling (2021)[13]	Class A – uses include irrigation of public open spaces (eg parks, sports fields), domestic garden watering including vegetable garden	No detection of *E. coli* (<1 cfu/100mL) (6 LRV of bacteria and protozoa, 7LRV of virus)	Unrestricted public access, any irrigation method
	Class B – Agricultural (eg dairy cattle grazing) and industrial (eg washdown water)	*E. coli* <100 cfu/100mL (secondary treatment and pathogen reduction)	(not specified)
	Class C – Urban (non-potable) with controlled public access	*E. coli* <1000 cfu/100mL (secondary treatment and pathogen reduction)	Controlled public access

5.6.3 Relevant consents

Examples of discharge to land consents for SRI systems with unrestricted or controlled public access are summarised in Table 14. Two other sites were considered, Pauanui Sports and Recreation Club (Coromandel) and Kinloch Village Golf Club (Taupo) but relevant information is not available in the consent database.

Table 14 Examples of relevant consents

Location & WWTP	Description	Type of system	Restrictions	*E. coli* limit	Sampling Frequency	Consent Issue/ Expiry
Greenacres Golf Course, Nelson (Bell Island WWTP)	Irrigate greens and fairways during irrigation season.	Surface sprinklers	Irrigate at night No irrigation with 24 hours of rainfall event	<10 cfu/100ml (Requires UV treatment & 7 LRV in virus)	Initially weekly, then 2 monthly over irrigation season	2023 / 2043

12 Taken from Table 3.8 in: Natural Resource Management, Ministerial Council Environment Protection and Heritage Council Australian Health Ministers' Conference. National Water Quality Management Strategy: Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1), 2006.
13 Taken from Table 1 in: Environment Protection Authority Victoria, Victorian guideline for water recycling Publication 1910.2, 2021

Location & WWTP	Description	Type of system	Restrictions	*E. coli* limit	Sampling Frequency	Consent Issue/ Expiry
	Up to 12 ha; up to 30 ha with reticulated wastewater supply		Signage			
Omaha Beach Golf Club, Auckland (Omaha WWTP)	Irrigate greens, fairways and, if needed, dunes. 25-30 ha	Subsurface irrigation	No restrictions Can irrigate any time of day No signage	<2 cfu/100mL (median) 250 cfu/100mL (92^{nd} percentile)	Weekly	2017 / 2037

5.6.4 Recommendation

On balance the following is recommended for sites with unrestricted public access to the SRI land application area:

– Subsurface irrigation (e.g. drip irrigation where drippers are covered by soil) – apply the same numeric limit as relevant Standard Class, based on Aggregated Risk Level and Site Capability Category.

– Above ground irrigation (e.g. sprinklers) – apply <1 cfu/100mL.

The recommendation could be incorporated as a footnote to the adopted table of numeric limits, consistent with final SRI report, or by adding separate column(s) to the table of numeric limits.

The recommendation only applies to SRI systems; ‘unrestricted public access’ is not considered appropriate for RIS systems.

6. Application Categories and Limits (Item 15)

This section provides responses to Priority Item 15, as outlined in Table 15. The following sections present comments and recommended actions.

Table 15 Priority Item 15 for Discharge to Land Standards

Item	Description (from Taumata Arowai)	Proposed approach
15. Application categories and limits	Some submissions said that the loading rate for TN and TP under class 1 was too high. Taumata Arowai require review of loading rates to ensure they are appropriate as part of the overall treatment framework. Some submissions said there should be more classes of categories for treatment / loading rates than is currently proposed (a small number apply to a large range of situations). Taumata Arowai require advice on whether there are the appropriate number of categories.	– Review proposals in submissions to be provided by Taumata Arowai Review consent applications to derive TN/TP loading rates and adjust or provide explanation as necessary – Review number of categories defined across Discharge to Land and RIS. Advise if more are required.

6.1 Previously proposed limits

Limits for total nitrogen and phosphorous and *E. coli* were previously presented in the 'Technical Advice on Wastewater Performance Standards: Discharge to Land' report. The recommended values were provisional and intended to initiate and facilitate discussion. These initial values are presented in Table 16.

Table 16 Limits for total nitrogen and phosphorous and E. coli were previously presented in the DtL report (SRI)

Class	Total Nitrogen* (kg / ha / yr)	Total Phosphorus* (kg / ha / yr)	*E. coli* (Public Health) (cfu/100mL in treated wastewater)
1	500	75	No limit*^
2	250	50	< 2,000^
3	150	20	< 1,000^

Notes:

- Considering the Risk Categories (1-5) and Site Capability Categories (1-5) have not been formally confirmed, the values provided are provisional and intended to initiate and facilitate discussion.
- The values assume the Risk Categories and Site Capability Categories follow a normal distribution for a potential receiving site, i.e. a Class 1 site meets numerous robust numerical assessments in terms of both risk and capability.
- ^The rationale for the values is presented in s3.3.4.1. The E. coli concentrations are for sites that apply restrictions on public access. For unrestricted public access sites, typically the E. coli concentration should be <1 cfu/100mL
- *The 'No limit' for E. coli (Class 1) assumes the pathway / receptor connection can be adequately removed. Should this be possible for Class 2 scenarios, the 'no limit' could also be considered for this Class.
- The loading rates (TN and TP) within each Class account for the total load from a site, including from the discharge itself and the land on which it is applied ~~and how it is managed (e.g. pasture / cut and carry~~; seasonal fertiliser application).

6.2 Submissions on Standard

Taumata Arowai provided excerpts of several submissions in relation to nutrient limits presented in the DtL Standards. Key matters raised with respect to application categories and limits were:

1. The nitrogen and phosphorus load limits in the table at the bottom right of page 29 of the proposed standards imply that total nitrogen is typically about five times the concentration of total phosphorus. This conflicts with the 1-10 times range of relationships between these nutrients for the proposed discharge to water standards. Water New Zealand's Good Practice Guide: Waste Stabilisation Ponds indicates that total nitrogen is typically about 3-5 times total phosphorus for pond-based WWTP's and typically about 1-3 times total phosphorus for WWTP's that include denitrification processes. The low phosphorus concentrations will have the

consequence of increasing sludge production at WWTP, which consequently needs to be managed. Consistency is required.

2. Nitrogen loads of 500 kg /ha/y seems to be a fairly high load that a system applying this level should require specialised input. This is particularly so given these higher rates will most likely be non-deficit, which may generate high losses of nutrients to groundwater and surface water. These high rates can easily exceed that which can be used for agronomic benefit, a catchment nutrient balance with offsets in nutrient loss from a non-wastewater application site is considered necessary to allow the high loading rate system's effects to be managed.
3. When hydraulic loads are elevated, soils and plants can become deficient in nitrogen, which may force scheme operators to add synthetic fertiliser to the land. This would defeat the purpose and cost of removing nitrogen from the treated wastewater before discharging it to land. It is much better to retain nitrogen in the form of ammonia in the treated wastewater as much as possible and irrigate it to land for maximum plant growth benefits. Consideration should be given not to over treat wastewater and instead aim to use the land as part of the treatment system and not just a dispersal area.
4. There is no explicit consideration of land management implications or nutrient removal by stock exports, cut and carry, or crop harvesting in the site capability assessment. However, the original GHD advice included all inputs (fertiliser and excreta) and exports (animals and harvesting) in these limits, so the total nitrogen and total phosphorus loads appear to be the net loads applied from all sources after subtracting all nutrient losses. The net load approach creates operational difficulties, while a set input load per ha, as mentioned earlier, is easy to administer and show compliance. The loading rate definition issue requires clarification.
5. Under the proposed discharge to land standard, Class 1 determines a load limit of 500 kg/ha/year for total nitrogen. The Council recommends a lower load limit as 500 kg/ha/year could lead to significant leaching and nitrate concentrations in groundwater that could exceed the Maximum Allowance Value (MAV) for drinking water, especially in the Canterbury area due to its soil structure. It could also result in breakthrough of pathogens into groundwater with irrigation or after rainfall events. Any load limit to land would also need to include the contribution that farming activity has on that land. Consideration should be given to the receiving surface water environment that the groundwater discharges to which is often more sensitive to nitrogen enrichment than groundwater drinking water standards.

6.3 Response to submissions

Responses to the points raised from submissions as provided by Taumata Arowai are listed below. The number of the response corresponds to the submission presented in Section 6.2.

1. The potential for a single parameter to be the limiting factor in the design of a WWTP is normal and is not considered to be an issue for the Standards.
2. Under the DtL Standard, Standard Class 1 loading rates (i.e., the highest loading rates) are only applicable when the proposed DtL meets Site Capability Category 1 or 2 (Table 10 in Priority Item 14) and an Aggregated Risk Level (Table 9 in Priority Item 14) 1 or 2, based on Table 4.7 in the RIS report (replicated in Table 12). A site where Standard Class 1 can be applied will have been assessed by a SQEP to meet at a minimum:
   a. DtL system has significant nutrient uptake (>400 kgN/ha/year) by vegetation, e.g., via cut and carry. This will reduce nutrient losses.
   b. DtL system is operated as a deficit scheme (below field capacity) or so the soil never reaches field saturation. This will minimise deep percolation.
   c. Has minimal receptors that could be potentially affected.
3. The application of synthetic fertiliser to land may be required to maintain vegetation cover. To address this the proposed Standard provides *total* nutrient loading limits for the DtL site, which includes the nutrient loading from the treated wastewater discharge itself as well as other on-site activities (e.g. seasonal fertiliser application).
4. Nutrient removal is a key component of a site's capability. The removal of nutrients has been considered in determining a site's capability and hence, determines what loading rate is suitable. See response Number 2.
5. See response Number 2. The aquifers widely utilised for drinking water supply in the Canterbury region would be a key receptor to any pathway picked up in the risk assessment. If a site is located near or may affect a

sensitive receptor it is highly unlikely to be determined by a SQEP as Standard Class 1. Therefore, lower loading rates would apply.

6.4 Review of existing consents

To assess what nutrient loads are currently being applied via SRI, the consented load for total nitrogen and phosphorus from some SRI schemes has been reviewed (Table 17). This assessment was limited due to the lack of readily available information within the consents database held by Taumata Arowai on nutrient loadings for total phosphorus.

The consented load has been compared to the previously proposed DtL limits (Table 16) to see what Standard Class(es) could theoretically be complied with, noting that there was insufficient information within the consents database to fully assess the Standard Class(es) that would apply for each site. Where the consented load does not theoretically comply with any Standard Class, it is stated as “doesn’t comply” in bold font.

Table 17 Average annual nutrient loads per hectare from consented SRI schemes compared to previously proposed limits

SRI site	TN annual loading rate (kgN/ha/yr)	TP annual loading rate (kgP/ha/yr)	Complies with TN for Standard Class	Complies with TP for Standard Class
Ashburton	305	-	Class 1	Not known
Blenheim	200	-	Class 1 & 2	Not known
Cardrona	449	120	Class 1	**Doesn’t comply**
Himatangi Beach	150	60	Class 1, 2, 3	Class 1
Lake Ferry	200	-	Class 1 & 2	Not known
Martinborough	300	-	Class 1	Not known
Moeraki	250 or 450 (if cut and carry)	250	Class 1 & 2 or Class 1 (if cut and carry)	**Doesn’t comply**
Omaha	53	-	Class 1, 2, 3	Not known
Otautau	450	280	Class 1	**Doesn’t comply**
Oxford	200	-	Class 1 & 2	Not known
Palmerston	150 or 400 (if cut and carry)	-	Class 1, 2 & 3 or Class 1 (if cut and carry)	Not known
Pines	204	-	Class 1 & 2	Not known
Pipiriki	150	-	Class 1, 2, 3	Not known
Rakaia	360	-	Class 1	Not known
Shannon	150	-	Class 1, 2, 3	Not known
Taupo	550*	-	Doesn’t comply	Not known
Tauwhare	260	-	Class 1	Not known
Te Anau	290	100	Class 1	**Doesn’t comply**
Wainui	200	-	Class 1 & 2	Not known
Whangamata	150	-	Class 1, 2, 3	Not known
Rotorua	402	89	Class 1	**Doesn’t comply**
Note: * Current consent states a maximum of 550 kgN/ha/year or any limit set following trial to demonstrate an acceptable higher loading rate of up to 650N/ha/year. SRI system is based on fixed spray and centre pivot to pasture, with cut and carry.				

SRI consents presented in Table 17 were primarily selected as they contained TN loading limits or a TN loading limit could be inferred (i.e. from TN concentration, flow and irrigation area). Whilst the Standard Class(es) for each site was not able to be assessed from the information within the consents database, the previously proposed TN loading limits for the Standard appear generally consistent with consented values. There are some exceptions, notably for one crop and carry system where the existing consent authorises a higher TN loading limit than that proposed for Class 1, which requires the DtL system to have significant nutrient uptake (>400 kgN//ha/year) by vegetation.

Typically, TP loading is not controlled under the SRI consents reviewed and, when present, the basis for the TP loading limit is unknown. Overall, the previously proposed TP loading limits for the Standard were lower than current consented values.

Analysis of *E. coli* loading limits was carried out as part of Priority Item 14 (Section 5). Whilst the focus was for that analysis was on unrestricted public access to SRI land application systems, it confirms there is no need to change the *E. coli* loading limits for the three Standard Classes with restricted public access.

6.5 Proposed revised limits for SRI

The technical team reviewed the previously proposed limits for SRI using the general approach developed for RIS. The approach involves considering the loading rate limits for each Standard Class across three methods as described in Section 5 and 5.1 in report titled 'Technical Advice on Wastewater Performance Standards – Rapid Infiltration Systems (RIS).

The inputs for each method were modified to reflect SRI, incorporating revised Site Capability Category descriptions presented in response to Priority Item 14 and loading rates from SRI consents summarised in Section 6.4.

Table 18 sets out the recommended amendment to the table in Section 2.16 of the 'Technical Advice on Wastewater Performance Standards: Discharge to Land' report (SRI report) to better reflect current consents and aligned through the methodology used for developing numeric limits for RIS. The loading rates (TN and TP) within each Class account for the total load to a site, including from the treated wastewater discharge itself and other on-site activities (e.g. seasonal fertiliser application).

Amendments in Table 18 as shown by deletions in strike-through text and additions in italics and underlined. Amendments are as follows:

– The TN loading limit for Standard Class 1 was increased from 500 to 550 kgN/ha/year to better align with outputs across the three methods, which included considering the revised Site Capability Category description for nutrient uptake by vegetation and current consents. No change to limits for Standard Class 2 or 3.
– The TP loading limits were generally increased to better align with outputs across the three methods, which included considering revised Site Capability Category description, TP removal rates from literature, and current consents.
– The *E. coli* limit for Standard Class 2 was increased from 2,000 cfu/100mL to 10,000 cfu/100mL to better align with outputs across the three methods as well as consideration of *E.coli* limits for RIS. No change to limits for Standard Class 1 or 3. For clarity of interpretation, the addition of a new column for *E.coli* limits for SRI sites with unrestricted public access has been provided instead of the previous footnote to the table; no change to numeric limit.
– Revisions to table notes to better reflect current status of DtL standard and recommendations from technical team.

Table 18 Revised DtL numeric limits for SRI

Standard Class	Total Nitrogen* (kg / ha / yr)	Total Phosphorus* (kg / ha / yr)	*E. coli* ~~(Public Health)~~ (cfu/100mL in treated wastewater) ***Restricted Public Access***	***E. coli (cfu/100mL in treated wastewater)*** ***Unrestricted Public Access***
1	~~500~~ *550*	~~75~~ *110*	No limit*^	*< 1*
2	250	50	< 10,000	*< 1*
3	150	~~20~~ *30*	< 1,000	*< 1*

Notes:

- ~~Considering the Risk Categories (1-5) and Site Capability Categories (1-5) have not been formally confirmed, the values provided are provisional and intended to initiate and facilitate discussion.~~
- ~~The values assume the Risk Categories and Site Capability Categories follow a normal distribution for a potential receiving site, i.e. a Class 1 site meets numerous robust numerical assessments in terms of both risk and capability.~~
- ~~^The rationale for the values is presented in s3.3.4.1. The E. coli concentrations are for sites that apply restrictions on public access. For unrestricted public access sites, typically the E. coli concentration should be <1 cfu/100mL~~
- *The 'No limit' for *E. coli* (Class 1) assumes the pathway / receptor connection can be adequately removed. ~~Should this be possible for Class 2 scenarios, the 'no limit' could also be considered for this Class.~~
- The loading rates (TN and TP) within each Class account for the total load to a site, including from the *treated wastewater* discharge itself and *other on-site activities* ~~the land on which it is applied and how it is managed~~ (e.g. ~~pasture / cut and carry;~~ seasonal fertiliser application).
- Numerical limits for TN and TP represent the maximum annual loading rate. The TN and TP annual loading rate is calculated by dividing the annual load by the land application area (**site**). The annual load is calculated as the sum of the monthly load using the total volume of treated wastewater discharged over the month and concentration for the treated wastewater recorded for that month. The **site** is the total land area over which treated wastewater is directly applied. The **site** is essentially the wetted area of the DtL system, including setback distances between irrigators, driplines, trenches, beds etc. The **site** excludes land area where treated wastewater is not directly applied on a routine basis, such as buffer distances (eg to sensitive receivers), DtL reserve area, WWTP and associated areas (eg access roads).
- Numerical limits for E.coli represent the annual 90th percentile. This is calculated from the treated wastewater monitoring results for concentration of E.coli for a given year.
- For **sit**es less than 1-hectare with a total application area less than 1-hectare or containing point source discharges:
  - Load is calculated as an average over a nominated 1-hectare area (i.e.: it is normalised to 1 ha). The load includes total nitrogen and total phosphorus from all other sources within the nominated 1-hectare area
- For **site**s greater than 1-hectare:
- Load is calculated directly on a per hectare basis in relation to the area over which the treated wastewater is applied.

It is noted that two factors determine the Standard Class(es), and hence numeric loading limits, for a given site: Site Capability Category and Aggregated Risk Level.

As part of Priority Item 14 (Section 5), it was recommended that for ***existing*** DtL systems, the Site Capability Category is undertaken as an 'on balance' or 'weight of evidence' approach, to be inclusive of all previous monitoring data and based on SQEP expert judgement.

Whereas, for all ***new*** DtL systems, where there isn't monitoring data to demonstrate the actual environmental effects associated with the DtL, the overall Site Capability Category for a site should be the highest (i.e. most precautionary) Site Capability Category based on all factors considered under the worst-case scenario.

6.6 Number of Standard Class Categories

Based on the review of existing SRI consents, particularly consented loading rates (numeric value, range and distribution of values), and that additional categories have been added for RIS systems, it is considered that additional DtL Standard Class categories (and hence loading rates) are not required.

7. Operation and Management Plan (Item 16)

This section provides responses to Priority Item 16, as outlined in Table 19. The following sections present comments and recommended actions.

Table 19 Priority Item 16 for Discharge to Land Standards

Item	Description (from Taumata Arowai)	Proposed approach
16. Operations and management plan	Taumata Arowai require advice on the areas that an operations and management plan must include as part of a consent (minimum requirements). Please also consider if are there other areas the Authority require advice on in this area as part of standards.	– Summarise key matters to be included at Order of Council level (and hence to be covered by guidance document). – Provide supporting reference(s). Likely USEPA and similar NZ guidance

7.1 Operation and Management Plan Requirements

A resource consent for a discharge to land system (‘system’) must specify the matters outlined in the section, as a minimum, are required to be addressed in the Management Plan and Operation and Maintenance Manual for the system and noting that these documents could be combined if desired. The following sections were compiled after reviewing 7 resource consents and associated hearing evidence, and the USEPA 2006. The requirements apply to slow rate and rapid infiltration systems.

Monitoring requirements are outlined in responses to Priority Item 17 (Section 8).

7.2 Management Plan

The purpose of the Management Plan is to describe how the system will be managed in all circumstances and how the management interfaces with the wastewater treatment system. It is intended to be used by managers and administrators.

The contents of the Management Plan will include:

- the objectives of the system
- summary description of the system including explanatory schematics and site layout plan
- the roles and responsibilities of those managing and operating the system, and a schedule of others involved, for example with maintenance, monitoring, and auditing
- the roles and responsibilities of those managing and operating the wastewater treatment plant (WWTP), and interface procedures with those managing the discharge to land system
- monitoring and reporting protocols, including any GW monitoring wells and surface water sampling
- emergency response procedures
- environmental risk mitigation strategies, including design review taking account of operational and environmental monitoring results
- contact information for suppliers, service providers, and regulators
- regulatory compliance documents including the resource consents
- a schedule of complementary plans and other documents and the purpose of each. Such documents may include a health and safety plan, environmental compliance and monitoring plan, site groundwater model (associated updating and effects assessments), training schedules, staff register and qualifications
- audit provisions
- complaints recording and investigation protocol
- management plan and operation and maintenance manual review requirements
- contingency protocol and establishment of triggers for investigation and action plan to resolve any issues arising

7.3 Operation and Maintenance Manual

The purpose of the Operation and Maintenance Manual is to detail the system, and how it should be operated, maintained, and monitored during normal and exceptional circumstances. It is intended to be used by those operating and maintaining the land application system.

The contents of the Operation and Maintenance Manual will include:

– as-built drawings
– protocols for operating the system safely
– methods and infrastructure for monitoring and managing the wastewater input (discharge from the WWTP and storage system) to the discharge to land system,
– methods and infrastructure for monitoring and managing the discharge to land of the wastewater including the operational performance of hydraulic, mechanical, electric and control systems including process flow diagrams, electronic controllers, and instrumentation, including (as applicable) weather, irrigation scheduling, soil moisture monitoring, cut and carry operations, and on-line tools
– detailed instructions for operating each component of the system
– monitoring and maintenance schedules and associated safety precautions and procedures, and equipment testing and replacement schedules
– equipment specifications and troubleshooting guides
– record-keeping schedules, templates, software, and filing provisions
– as-built drawings and schematics
– manufacturer operating and service manuals and service contacts
– emergency conditions, design mitigation provisions, complaints register, and operational response procedures.
– templates and systems to record inspections, maintenance, incidents and monitoring results

8. Monitoring Requirements (Item 17)

This section provides responses to Priority Item 17, as outlined in Table 20. The following sections present comments and recommended actions.

Table 20 Priority Item 17 for Discharge to Land Standards

Item	Description (from Taumata Arowai)	Proposed approach
17. Monitoring requirements	Taumata Arowai require final advice on the monitoring requirements (groundwater and soil) that will apply as part of discharge to land standard based on advice in technical report, and confirmation of how these will link to an O&M Plan.	– Summarise key matters to be included at Order of Council level (and hence to be covered by guidance document). – Provide supporting reference(s) Likely USEPA and similar NZ guidance.

8.1 Key matters for Order in Council

The minimum on-going monitoring requirements to demonstrate compliance for wastewater schemes involving discharges of treated wastewater to land for the Order in Council are summarised in Table 21. The minimum requirements apply to both slow-rate and rapid infiltration systems, regardless of the size of the wastewater scheme.

Table 21 Minimum on-going monitoring requirements for DtL for Order in Council

Aspect	Location	Parameters	Frequency	Purpose
Treated wastewater	One sample point at 'end-of pipe', prior to discharge to land application area (e.g. in irrigation tank)	TN (mg/L) TP (mg/L)	Monthly	Calculate annual TN and TP areal loading rate. For detail on calculation, see notes to Table 18 (numeric limits)
		E. coli (cfu/100mL)	Monthly	Calculate annual 90th percentile *E. coli* concentration. For detail on calculation, see notes to Table 18 (numeric limits)
		Flow (m^3/day)	Total Flow for each day recorded daily	Calculate annual TN and TP areal loading rates
Land application area	Area of land that treated wastewater is routinely applied to	Land area (ha)	Daily operational log	Demonstrate treated wastewater is being applied to full extent of intended land application area Calculate annual TN and TP areal loading rates
Groundwater	One groundwater monitoring bore in suitable location downgradient and, where practicable, upgradient of land application area.	TN (mg/L) TP (mg/L) *E. coli* (cfu/100mL)	Monthly	Demonstrate land application system operating as intended based on adopted Site Capability Category and Aggregated Risk Level. Downgradient bore located to monitor far-field effects (e.g. 100 to 500m downgradient)

Aspect	Location	Parameters	Frequency	Purpose
				Upgradient bore is a control, located to understand ‘background’ groundwater quality
Other	Additional monitoring as identified as required by a Suitably Qualified and Experienced Practitioner (SQEP) based on site specific attributes.			

In addition to the minimum ongoing monitoring requirements, as further discussed below in Section 8.2, a Suitably Qualified and Experienced Practitioner (SQEP) should consider site specific attributes and determine whether the minimum requirements should be supplemented with additional monitoring. The SQEP will specify:

– Site-specific monitoring required to verify baseline, risk and site capability assessments for existing and new land application systems
– Operational and environmental monitoring required to demonstrate long term sustainable performance of the land application system

A regional council may require additional monitoring is carried out related to matters not covered by the DtL standard (e.g. other contaminants not covered by the DtL Standards).

All laboratory analyses of samples must be undertaken by an International Accreditation New Zealand (IANZ)-accredited laboratory provider.

8.2 Matters to be addressed in operational management plans and national guidance

While the Order in Council will specify minimum ongoing requirements for the monitoring of discharges of treated wastewater to land, the SQEP will specify any additional site-specific monitoring, appropriate for the size of the wastewater scheme, required to verify assessments as well to ensure the validity and robustness of ongoing operational and environmental monitoring to demonstrate land application system performance. It is expected that certain aspects of the monitoring requirements will need to be developed in further detail to provide guidance to consent holders and ensure that the Standards are interpreted and implemented consistently across the country. Matters discussed in this section are intended to be integrated into the requirements for Operational Management Plans and associated guidance.

Matters for the SQEP to address, where required, in the Operational Management Plan for a site:

– Appropriate sampling frequencies and number of monitoring locations in addition to those specified in Table 21, based on the site’s Risk Level, Site Capability Category, size of area of land that treated wastewater is routinely applied to (in hectares) and proximity to sensitive receptors. Monitoring locations must be representative of both reference (i.e. control, or baseline/background) and potentially impacted conditions. This could include monitoring of treated wastewater, soil, groundwater and surface water as required by the SQEP.
– On-site monitoring of soil properties such as soil moisture, structure and nutrient related factors to inform when and how to best apply the treated wastewater.
– Comparison and reporting of the monitoring results to proactively identify any potential contamination or operational issues and recommend remedial actions if required.
– Schedule for site inspections including the frequency, who should undertake the inspections, an inspection checklist, and instructions regarding how any issues and corrective actions should be included.
– Survey of groundwater bores within the same aquifer to track changes in groundwater users (that may be impacted by the discharge) over time. of groundwater bores within the same aquifer to track changes in groundwater users (that may be impacted by the discharge) over time.
– Additional analytes required over and above the minimum requirements depending on the site characteristics and particularly influent characteristics and associated risks (for example, if there is a known source of heavy metals). and particularly influent characteristics and associated risks (for example, if there is a known source of heavy metals).

– Inclusion of trigger action response plan (or similar) for selected parameters, whereby if a particular parameter breeches a pre-determined threshold, particular actions are required.
– Any other operational or environmental matters identified by the SQEP as being required to demonstrate long term sustainable performance of the land application system.

Additional aspects to consider include, but may not be limited to, those listed in Table 22 below. Some of these will inform whether the site remains appropriate for continued application of treated wastewater or whether the operational regime needs to be adjusted to minimise the potential for adverse environmental impacts.

Table 22 Additional Aspects to Consider in Site-specific Monitoring Plan

Aspect	Treated wastewater	Soil	Groundwater	Surface Water
Monitoring locations	Number of additional sampling locations.	Number of sampling locations per application area(s).	Number of additional monitoring bores (and distance) upgradient, within and downgradient of land application area(s) For RIS only, number of monitoring bores located beneath application area.	Where discharge is expected to intercept surface water, number of sampling locations (e.g. upstream and downstream of discharge to water)
Quantity parameters and frequency	– More frequent Logging of Instantaneous Flow in addition to the total daily flow – Monitoring device, accuracy and calibration – Frequency (e.g. continuous monitoring)	– Infiltration rate (for SRI)	– Groundwater level in bores. – Frequency	– Estimate of flow in river (e.g. stage or water level)
Quality Parameters and frequency	– pH (in-situ only) – Electrical conductivity – Total Suspended Solids – Carbonaceous 5-day biochemical oxygen demand (cBOD5) – Dissolved oxygen (in-situ only, in % saturation and mg/L) – Dissolved organic carbon – Total ammoniacal-nitrogen – Nitrate-nitrogen – Nitrite-nitrogen – Chloride – Dissolved reactive phosphorus – Enterococci (where discharge expected to intercept marine water)	– pH – Soil moisture – Olsen phosphorus (Olsen P) – Sodium adsorption ratio (SAR) – Phosphorus Retention Index (applicable for RIS) – Cation Exchange Capacity – Total Kjeldahl Nitrogen – Total phosphorus – Total organic Carbon (or other measures of carbon content / organic matter) – Trace elements and other contaminants depending on background condition and influent characteristics (e.g. total recoverable	– pH (in-situ only) – Electrical conductivity – Total ammoniacal nitrogen – Nitrate nitrogen – Dissolved reactive phosphorus – Chloride – Total, dissolved and/or acid soluble heavy metals – Total Petroleum Hydrocarbons – Polycyclic Aromatic Hydrocarbons (PAH) – Polychlorinated biphenyls (PCB) – Total Suspended Solids (TSS) – Carbonaceous 5-day biochemical oxygen demand (cBOD5) – *Enterococci* (where discharge expected to intercept marine water)	– pH (in-situ only) – Electrical conductivity – Ambient water temperature (in-situ only) – Dissolved oxygen (in-situ only, in % saturation and mg/L) – Nitrate-nitrogen – Total ammoniacal-nitrogen – Total nitrogen – Total phosphorus – *E. coli* (or Enterococci in a marine environment) – Turbidity (in-situ only) – Chloride – Periphyton (in freshwater) or Chlorophyll- α (marine water) – TSS – Dissolved organic carbon (if copper or

Aspect	Treated wastewater	Soil	Groundwater	Surface Water
	– Other contaminants depending on influent characteristics (e.g. heavy metals; total petroleum hydrocarbons)	metals; total petroleum hydrocarbons)		zinc are contaminants of concern) – Total, dissolved and/or acid soluble heavy metals – Total Petroleum Hydrocarbons – Polycyclic Aromatic Hydrocarbons (PAH) – Polychlorinated biphenyls (PCB)

Matters to be addressed in national guidance materials include:

– Select an appropriate method for determining the number of sampling locations required (for soil, groundwater, and surface water receiving environment monitoring, as well as for monitoring of the treatment process and the final treated wastewater prior to discharge). Methods should take into account the size of the scheme and the application area; the expected variability across the site and receiving environments (e.g. are underlying soils homogeneous, or highly variable?); the Risk Level and Site Capability Category for the site, and the degree of knowledge already held.

– Specify recommended sampling protocols, including reference to other guidance such as those outlined in Table 23 (at minimum).

– A list of acceptable laboratory analysis methods for the parameters that need to be monitored to comply with the Standards. This should be developed in collaboration with New Zealand's leading IANZ-certified laboratory providers and researchers including ESR, AsureQuality, Cawthron Institute, RJ Hill Laboratories Ltd (Hill Labs), Eurofins, SGS New Zealand Ltd, Watercare Services Limited, and ALS Environmental NZ (as examples). Recommend working initially with IANZ to coordinate feedback/technical input.

Table 23 References to external guidance for environmental monitoring

Treated wastewater	Soil	Groundwater	Surface water
NZWERF 2002 *New Zealand Municipal Wastewater Monitoring Guidelines*, new Zealand Water Environment Research Foundation (now part of Water NZ), October 2002. APHA / AWWA / WEF *Standard Methods For the Examination of Water and Wastewater*, 24th edition (2023); American Public Health Association, American Water Works Association, Water Environment Federation.	*Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011*; in particular, the Contaminated Land Management Guidelines No 5 (CLMG5) – site investigation and analysis of soils (Revised 2011). *National Environmental Monitoring Standards (NEMS) 2022 Soil Quality and Trace Element Monitoring*, Version 1.0.0, Available from: https://www.nems.org.nz/documents/soil-quality-and-trace-element-monitoring	*ISO 5667-22:2020 Water quality — Sampling — Part 22: Guidance on the design and installation of groundwater monitoring points.* *Water Quality Part 1 - Sampling, Measuring, Processing and Archiving of Discrete Groundwater Quality Data, NEMS, 2019. Available from: https://www.nems.org.nz/documents/water-quality-part-1-groundwater* NZS4411:2001 – Environmental Standard for drilling of soil and rock (applicable for all groundwater monitoring bores constructed) Rosen M R, Cameron S G, Taylor C B, Reeves R R 1999 *New Zealand Guidelines for the Collection*	AS/NZS 5667:1998 – *Water quality – Sampling* MfE 2003 *Microbiological water quality guidelines for marine and freshwater recreational areas*, Ministry for the Environment ANZG 2018 *Australian and New Zealand Guidelines for Fresh & Marine Water Quality*; particularly online resources providing guidance for monitoring program design and analyses approaches (e.g. https://www.waterquality.gov.au/anz-guidelines/monitoring/study-design) National Environmental Monitoring Standards (NEMS) 2017 *Water quality: Part 2 of 4: Sampling, measuring, processing and archiving of discrete river*

Treated wastewater	Soil	Groundwater	Surface water
		of Groundwater Samples for Chemical and Isotopic Analysis, Institute of Geological and Nuclear Sciences Science Report 99/9.	*water quality data*. Version 1.0, DRAFT (released publicly for review on 16 October 2017) Available from: http://nems.org.nz/documents/water-quality-part-2-rivers/

9. Exclusions (Item 18)

This section provides responses to Priority Item 18, as outlined in Table 24. The following sections present comments and recommended actions.

Table 24 Priority Item 18 for Discharge to Land Standards

Item	Description (from Taumata Arowai)	Proposed approach
18. Exclusions	Exclusions (situations where the discharge to land standard should not apply) are set out in the technical report and Taumata Arowai do not require any further advice at this stage. We will review submissions against these exclusions and come back to you if further advice is required.	– The consultant team will be producing more exclusions for the Rapid Infiltration workstream, so we suggest a meeting to discuss exclusions on a whole with Taumata Arowai (2 hours for 3 people).

9.1 Definitions of slow and rapid infiltration

The discharge to land standard applies to both slow rate and rapid infiltration systems. The definition for rapid infiltration systems (RIS) has recently been refined through the Technical Advice on RIS work package. The definition was discussed in Section 2.2 of the technical report[14] and the final definition is summarised below, in Table 25.

Table 25 RIS definition, method and key assumptions

Definition	Discharge method examples	Key assumptions
Land treatment systems which discharge on or into land where the Annual Hydraulic Load exceeds 6 m per year	RIS systems include a vast array of discharge methods and terminology. Examples include: – Land discharge to ground via excavated or bunded trenches, basins and beds or a closely spaced subsurface pipe network that achieves spatial spread of the discharge. – Soakage pits, horizontal or vertical perforated piped systems (including wells) that discharge above the water table.	– All treated wastewater is contained within the designated discharge area and infiltrates through the soil, resulting in no runoff or direct discharges to surface water bodies. – Standing treated wastewater above the infiltration surface is acceptable within the designated discharge area. – No direct discharge to groundwater.
Notes: The RIS Annual Hydraulic load varies significantly. The typical range for New Zealand sites and based on the literature is 6 m to 150 m per year. RIS sites with an Annual Hydraulic loading rate greater than 30 m per year will typically occur in coarser soils and have a lower level of soil treatment.		

Following the development of this definition, modifications have been made to the initial slow rate infiltration (SRI) definition which was previously discussed in Section 2.8 of the initial Technical Advice on Discharge to Land Standard Report[15]. The updated definition for SRI systems is:

[14] 12669824-Technical Advice on Wastewater Performance Standards – Draft: Rapid Infiltration Systems (RIS). Draft release dated 11-07-25.
[15] **12656252_GHD_REP - Technical Advice on Discharge to Water Standards - REV0.docx**

Systems where the annual hydraulic loading rate is less than 6 m per year. Typically, applications events are less than 5 mm/hour, or 15 mm per application event

The reason for this update is to align the definitions of RIS and SRI to ensure there is not an instance between the two defined annual hydraulic loading rates where a system would be subject to being excluded from the Standard.

On this basis, if the annual hydraulic loading rate is less than 6m per year any SRI specific exclusions apply, and RIS specific exclusions and requirements are not relevant. If the annual hydraulic loading rate is greater than 6m per year, any RIS specific exclusions apply, and the SRI specific exclusions and requirements are not relevant.

9.2 Exclusions from the Discharge to Land Standard

The exclusions, situations where the Discharge to Land Standard should not apply, have been revised as result of the responses to other Priority items and the need to align the Risk Assessment Framework across both RIS and SRI.

The following exclusions therefore apply to the Discharge to Land Standard:

– Any direct discharges into groundwater.
– Any periodic wastewater treatment plant bypass discharges.
– Discharge to natural and or constructed wetland(s).
– Areas which are wāhi tapu, tūpuna, and other sites on Rarangi korero / NZ heritage list.
- If the site capability is deemed category 5, it is unsuitable, and mitigations are required to reduce the category, or an alternative site must be considered.
- If the site capability is deemed category 4, and the aggregated risk level is a level 4, the Standards cannot be applied unless mitigations can be implemented to reduce the site capability category and / or the aggregated risk level. If neither can be mitigated to an appropriate level an alternative site / option must be considered.
- For SRI only: Discharges to land for water reuse or recycling, which requires a higher level of treatment. This includes irrigation of crops for human consumption, irrigation of pasture or crops for animal consumption, irrigation of public amenities with unrestricted access (based on limits for Standard Class; higher wastewater quality limits to enable this activity proposed under Priority Item 14).
– For RIS only: Discharges for Managed Aquifer Recharge (MAR) which have different primary objectives, generally related to enhanced groundwater storage, water quality improvements and water management.

It is important to note, the application of limits for Total Suspended Solids (TSS) and biological oxygen demand (BOD_5) are also excluded from the Discharge to Land Standards.

9.3 Site Selection and Operational Exclusions

Whilst not exclusions from the Standards, a range of other factors become site specific or operational factors, which may inhibit the site from being suitable for land application of treated wastewater. These include:

- Limiting factors determined as an outcome of the Baseline or Risk Assessment.
- Factors defined in the Site Capability Assessments, including but not limited to the drainage, soil type, depth to groundwater, land use, and topography of the site.
- Operational practices that must be followed (assumed to be applied), including but not limited to
  - Standdown / rest periods
  - Exclusions from application areas for stock, other animals (pets), and the public. This may always apply to the site or during and following application, depending on the system.
  - Design application rates and soil permeability
  - Monitoring requirements (operational and environmental).

Project name	Technical Advice on WW Discharge Standards - Phase 2
Document title	Report – Final | Additional Advice on Priority Items relating to the Discharge to Water Standard
Project number	12669824
File name	12669824_Discharge to Land_Priority Items_Final_Rev0.docx
Status	Rev 0
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Appendix B

Definitions of RIS from literature

A review of international literature and standards, primarily from Australia, the United States, and New Zealand, reveals a range of definitions and applications for RIS. Common elements across definitions include the controlled application of treated or partially treated effluent to permeable soils, subsequent percolation through the soil profile, and treatment through processes including filtration, sorption, ion exchange, and microbial degradation. These systems are engineered to meet environmental performance criteria and mitigate impacts beyond the discharge zone. RIS configurations can include basins, trenches, beds, or mounds. Another method involves subsurface discharge methods using pipe networks or wells configured horizontally or vertically. While vegetation may be present, its contribution to treatment is generally minor due to limited contact time between plants and effluent and/or the depth of discharge in the soil profile. The systems are particularly suited for treating large volumes of wastewater within smaller areas, especially in regions with suitable soil and hydrogeological conditions.

A review of international literature, including guidelines and standards from Australia, the USA, and New Zealand, has identified several definitions for RIS, summarised in the table below.

Table B.1 Rapid Infiltration definitions from international Literature

Reference	Definition
UK Definition (Gov.UK, 2016)	Rapid Infiltration Systems (RIS) are land-based wastewater treatment and disposal methods that involve the application of treated effluent to the soil surface, where it percolates through the subsurface. As the effluent infiltrates, it undergoes further treatment through natural physical, chemical, and biological processes. These systems are designed to maximise infiltration rates, treat large volumes of wastewater, and meet prescribed performance standards. Treated water may either recharge underlying groundwater or be recovered for reuse, with systems specifically engineered to minimise environmental impacts beyond the discharge zone.
NZ Definition (GHD, Beca, Boffa Miskell, 2020)	Rapid infiltration involves the controlled application of wastewater to earthen basins on highly permeable soils, where it infiltrates and moves through the soil matrix toward a water body or is recovered via subsurface pumping. Vegetation may be present but plays a minimal role in treatment due to limited contact time with the wastewater.
UK, London Definition (Guida, 2021)	An RIS is a land-based wastewater disposal method that harnesses the soil's natural filtering capacity. As wastewater percolates through the porous soil, it is treated through physical straining, chemical precipitation, ion exchange, adsorption, and biological processes including oxidation and reduction. Depending on its quality and regulatory requirements, the treated effluent may be discharged into surface or groundwater or recovered for further processing or reuse. *Note: Reuse is beyond the scope of this Standard (refer to Section 1).*
US, Minnesota Definition (Wilson, 2005)	Rapid Infiltration Basins (RIBs) are wastewater treatment systems that involve cycles of flooding, infiltration, and drying. These systems rely on the soil's natural filtering capacity to remove pathogens and nitrogen from the wastewater. The design includes considerations for soil requirements, hydraulic loading rates, and groundwater mounding.
US, Nevada Definition (NDEP, 2017)	Rapid Infiltration Systems (RIS) are methods for disposing of wastewater by allowing it to percolate through the soil, where it undergoes physical, chemical, and biological treatment. The treated water then recharges groundwater or is collected for reuse. RIS are designed to achieve prescribed technical performance standards in terms of managing potential environmental effects beyond a zone of discharge.
US, Ohio Definition (USEPA, 2006)	Rapid Infiltration Systems (RIS) are land-based wastewater treatment methods that leverage the natural filtering capacity of the soil ecosystem. Pretreated wastewater is intermittently applied to shallow earthen basins with exposed soil surfaces, where it percolates through the porous soil matrix and undergoes a series of treatment processes including physical straining, chemical precipitation, ion exchange, adsorption, and biological mechanisms such as oxidation, assimilation, and reduction.
US, Washington D.C Definition (USEPA, 2003)	Rapid Infiltration Systems (RIS) are a class of land-based wastewater treatment and disposal technologies that rely on the soil's natural capacity to filter and treat effluent. During this process, the effluent is treated by a combination of physical, chemical, and biological processes such as filtration, adsorption, ion exchange, and microbial degradation. The treated water may recharge groundwater, be collected for reuse, or be discharged to surface waters, depending on regulatory requirements and water quality outcomes. *Note: Reuse is beyond the scope of this Standard (refer to Section 1).*

Appendix C

Examples of hazards and risks associated with RIS

Table C.2 Examples of hazards (and potential associated risks) relevant to RIS

Potential Hazard	Associated Risk(s)	Potential outcome (effect)
High levels of inorganic contaminants (e.g. nitrate, ammoniacal-nitrogen) in treated wastewater	Contamination of groundwater	– Compromise potential future uses (e.g. nitrate toxicity) – Adverse effects on public health due to compromised drinking water supply
	Contamination of surface water	– Toxic effect on aquatic life (e.g. ammoniacal-nitrogen resulting in fish deaths)
High levels of nutrients (Nitrogen, phosphorus) in treated wastewater	Contamination of receiving water bodies	– Eutrophication (leading to toxic algal blooms, for example) – Exacerbation of existing high levels of nitrogen and phosphorus, where these are already elevated at or close to Maximum Acceptable Value (MAV) in a drinking water source protection zone
High levels of pathogens in treated wastewater	Contamination of groundwater	– Adverse effects on public health due to compromised drinking water supply protection zone (groundwater source) – Domestic private drinking water bore is compromised leading to public health notice
	Contamination of surface water	– Illness in swimmers who had contact with contaminated surface water – Illness in people who consume contaminated shellfish – Adverse effects on public health due to compromised drinking water supply (surface water source)

Table C.3 Factors influencing the quality of risk assessment for RIS.

Type of factor	Factors influencing risk	Examples
Site specific characteristics	Surface features	Topography, land use, vegetation cover, hydrological connectivity
	Sub-surface conditions	Soil profile, permeability, mineralogy, geology, groundwater depth and flow regime, drainage impediments, spatial and vertical heterogeneity
	Physiographic setting	Catchment context, recharge zones, floodplains, slope stability
	Natural hazards	Seismicity and fault lines, flooding, landslides, drought, rockfall and/or slope stability
Local and Regional Context	Land use and social setting	Zoning, existing land practices, neighbouring land use, proximity to sensitive receptors
	Cumulative effects	Overlapping discharges, legacy contamination, and catchment-scale pressures
	Demographics	Current and projected population density and land demand
Regulatory and Guidance Framework	Applicable legislation	National environmental standards, discharge consents, land use controls
	Standards and guidelines	ANZG, MfE, regional plan requirements, industry codes of practice
	Cultural considerations	Statutory acknowledgements, iwi management plans (even if outside direct scope)
Wastewater Treatment System Characteristics	Existing infrastructure	Type, age, performance, and compliance status of treatment and land application systems
	Wastewater characteristics	Volume, variability, quality and expected changes over time. Quality considerations include Nutrients, Faecal Coliforms, TSS, Turbidity, BOD
	Soil treatment capacity	Assimilative potential, texture, structure, permeability and water holding capacity
Knowledge and Tools	Available information	Site investigations, monitoring data, previous reports
	Environmental and design models	Contaminant fate models, groundwater transport models

Type of factor	Factors influencing risk	Examples
	Model inputs and outputs	Calibration data, sensitivity, uncertainty ranges
	Research and case studies	Peer-reviewed literature and lessons from comparable sites
Resources and Capability	Expertise	Availability of suitably qualified and experienced professionals
	Logistics and tools	Access to labs, plant and equipment, and analytical methods
	Funding and timeframes	Resources allocated for investigation, piloting, and adaptive management
	Data access	Permissions, formats, and interoperability

Appendix D

Risk Assessment Examples

Presented below is some support information to assist with understanding.

Table D.4 Considerations for assessing risk to drinking water supplies from groundwater.

Factor	Risk to human drinking water supplies from groundwater					Technical basis
	Low	Low	Medium	High	Critical	
Abstracted aquifer **(well or spring) at drinking water source**	Abstraction from a different aquifer not impacted by the discharge and considered hydraulically disconnected from the impacted aquifer (i.e. this could be a well that sources groundwater from a deep aquifer not connected to a shallow aquifer impacted by the discharge). **AND**	Abstraction from the same aquifer impacted by the discharge, and / or, different aquifer that is hydraulically connected to the impacted aquifer. **AND**	Abstraction from a different aquifer not impacted by the discharge but: • aquifer has a moderate to high connection to the impacted aquifer (i.e. similar water quality trends and limited presence of confined units) and / or • the well may have casing integrity issues (i.e. very old well, upper casing may be leaking / connected to shallow aquifer impacted by the discharge) and / or • lack of information on well construction: (i.e. well has no screen depth information so maybe screened into aquifer impacted by the discharge). **AND**	Abstraction from the same aquifer impacted by the discharge. **AND**	Abstraction from the same aquifer impacted by the discharge. **AND**	General comments: Lowest risk – take from aquifer not impacted by the discharge. Medium risk – take from aquifer not impacted by the discharge but where there is a moderate to high hydraulic connection to the impacted aquifer, and or lack of information on the well construction or casing issues. High risk - take from impacted aquifer close to discharge.
Modelling – Pathogens at drinking water source	SPZ1 and SP2 **do not** overlap the discharge. **AND**	SPZ1 and SPZ2 **do not** overlap the discharge. **AND**	SPZ1 and / or SPZ2 **overlap** the discharge. **AND / OR**	SPZ1 does not overlap the discharge, but SPZ2 boundary close to discharge and aquifer is highly permeable and or difficult to characterise (i.e. karst aquifer). **AND / OR**	SPZ1 and / or SPZ2 **overlap** the discharge. Consequently, there is predicted exceedance of the MAV at the location of the take. **AND / OR**	SPZ1 and SPZ2 are based on MfE (2018) guidelines for protection from pathogen contamination.
Modelling -Nitrate-nitrogen at drinking water source	SPZ3 **does not** overlap the discharge. **AND**	SPZ3 **overlaps** the discharge and the predicted effect of the discharge and other land uses results in concentrations less than half the MAV at the take. **AND**	SPZ3 **overlaps** the discharge and the predicted effect of the discharge and other land uses result in a low to moderate probability that concentrations will exceed the MAV in the impacted aquifer at the take. **AND / OR**	SPZ3 **overlaps** the discharge and the predicted effect of the discharge and other land uses result in a low to moderate probability that concentrations will exceed the MAV at the take. **AND / OR**	SPZ3 **overlaps** the discharge and the predicted effect of the discharge and other land uses result in moderate to very high probability that concentrations will exceed the MAV at a take. **AND / OR**	SPZ3 are based on MfE (2018) guidelines for protection from pathogen contamination. MAV is the Maximum Acceptable Value for human health based on the Drinking Water Standards for New Zealand, Regulations 2022.
Monitoring data at drinking water source	No measured or anticipated impacts from the discharge. Stable or decreasing trends water quality trends. Raw water quality well below MAV.	No measured or anticipated impacts from the discharge. Stable trends.	Concentrations sometimes at or close to the MAV. Maybe increasing trends	Concentrations sometimes exceed the MAV. Maybe increasing trends.	Concentrations often or constantly exceed the MAV. Increasing trends.	Monitoring pathogens and nitrate-nitrogen at drinking water supplies. Confirm validity of modelling.
Identification of take locations / use / well construction details at drinking water source	Recent and continually updated field verification and register of drinking water source locations and water uses over time. Bore construction, geology, water quality and water level data available for all nearby sites.	Less recent field verified location and water use from undertaken, so some information may be old and potentially outdated. Records match well to Council records and critical information like well screen depths and geology is known, but some other data such as water levels could be missing.	Not field verified so potential for existing and potentially affected wells to be missed based on a desktop assessment only. Council records and desktop information is good and critical information like well screen depths and geology are available.	Not field verified so potential for existing and potentially affected wells to be missed based on a desktop assessment only. Council records and other desktop information is limited and missing some critical information like well screen depths and geology.	Not field verified and high potential for existing and potentially affected wells to be missed based on a desktop assessment only, given a high number of sites may be present. No council records or other desktop information.	The level of information on existing and proposed wells affects the level of risk. Identifying potentially affected wells or wells with measured effects, enables risk mitigation (i.e. provide an alternative supply).

Table D.5 Framework for assessing drinking water supplies from surface water and aquatic ecosystem health.

Factor	Risk to surface water on human drinking water supplies and aquatic ecosystem health					Technical basis
	Low	Low	Medium	High	Critical	
Surface water impacts after mixing (key matrix)	Surface water standards and targets are met after mixing. Based on: • Limited or no factors that indicate high risk to surface water • No impacts to surface water either measured or modelled.	Surface water standards and targets are likely met after mixing. Based on: • Limited factors that indicate high risk to surface water. • No impacts to surface water either measured or modelled.	Surface water standards and targets may not be met after mixing. Based on: • Some factors present that indicate potential risk to surface water. • Modelling suggest impacts possible.	Surface water standards and targets are not met after mixing. • Many factors present that indicate potential risk to surface water. • Modelling suggest likely impacts likely.	Surface water standards and targets are not met after mixing. • Many critical factors present that indicate potential risk to surface water. • Modelled impacts. • Measured impacts.	Given the complexities of assessing surface water contamination from impacted groundwater, a site specific assessment of the surface water body against relevant standards and targets is the primary means of assessing risk. Other factors below may help to assess the level of risk.
Surface water connection to groundwater	No connection (pathway) from groundwater to nearest surface water body within the vicinity of the discharge.	Surface water intermittently or with minimal hydraulic connection to impacted groundwater. Groundwater unlikely to flow towards surface water. Greater than 1-year time of travel in groundwater before reaching surface water. **AND**	Surface water in direct hydraulic connection too (i.e. groundwater discharge to surface water) Some groundwater is likely to flow in the direction of the surface Less than 1-year time of travel from impacted groundwater. water. **AND**	Discharge located 10 m - 50 m from surface water that is in direct hydraulic connection to impacted groundwater (i.e. groundwater discharge to surface water). There is less than 1-year time of travel from impacted groundwater to surface water. Groundwater flows in the direction of the surface water body. Springs located near the proposed discharge. **AND / OR**	Discharge located within 10 m of surface water. Surface water in direction hydraulic connection too and less than 1-year time of travel to impacted groundwater. Groundwater flow directly towards surface water. Observable groundwater discharge close to wastewater discharge and directly into the connected surface water (i.e. springs). **AND**	Ideal sites located where there is no connection (pathway) for groundwater to enter surface water, and no impacts on surface water, regardless of the impacts on groundwater. 1-year time of travel based on MfE (2018) SPZ2 for protection against pathogen contaminant. Distances of < 10 m and 10 m – 50 m considered appropriate for higher risk sites where groundwater is connected surface water. 10 m set-back distance in Environment Agency & DEFRA (2016)
Modelling – contaminants	Not necessary.	Modelled contaminant concentrations in groundwater adjacent to surface water resulting from combined effects of the discharge and other land uses is below human health MAV and / or aquatic ecosystem guidelines. **AND / OR**	Modelled contaminant concentrations in groundwater adjacent to surface water resulting from combined effects of the discharge and other land uses sometimes exceed human health MAV, and / or aquatic ecosystem guidelines. Result in possible exceedances in connected surface water. **AND / OR**	Modelled contaminant concentrations in connected surface water including impacts from the discharge sometimes exceed the human health MAV and / or aquatic ecosystem guidelines. **AND / OR**	Modelled contaminant concentrations in connected surface water including impacts from the discharge are consistently above human health MAV and / or aquatic ecosystem guidelines. **AND / OR**	Difficult to model (quantify) in practise due to complexities involved with contaminant transport in groundwater and connection to surface water. However, should be undertaken to help assess risk.
Monitoring - contaminants	No measured change in water quality from the discharge either in groundwater adjacent to surface water, or in surface water itself. Stable or decreasing trends	No measured changes in water quality from the discharge in either surface water or the adjacent groundwater. Stable trends.	Monitoring data suggests possible water quality changes in surface water and clear water quality changes in adjacent groundwater. Stable trends.	Measured concentrations in surface water sometimes exceed human health MAV and / or aquatic ecosystem guidelines due to the discharge and or in combination with other activities.	Measured concentrations in surface water often or constantly exceed human health MAV and / or aquatic ecosystem guidelines due to the discharge and or in combination with other activities. Increasing trends.	Compare upstream and downstream sampling to determine if there is an impact from the discharge. Also consider the site conceptual model, in particular, groundwater connection to surface water. Confirm impacts and validity of modelling.
Surface water takes	No surface water takes.	Small number, significant distance downstream of discharge.	Small number in close proximity downstream of discharge.	Large number downstream of the impacted surface water.	Large number immediately downstream of impacted surface water.	Risk dependent on the number and size of the takes, and proximity to any impacted surface water.

Appendix E

Literature review of Consequence Ratings

Table E.6 Human Health Consequence Ratings and Descriptors from literature (for health effects resulting from treated wastewater discharge)

Consequence Rating	Descriptor: Public Health			
	(EPA Victoria, 2021)	(Lane & Hrudey, 2023)		
		NZ	Global (World Health Organisation)	South Africa
Insignificant	None of community ill in relation to discharge	Insignificant	Insignificant or no impact	No impact
Minor	Very few of community ill affected by discharge	Minor impact for small population	Minor compliance impact	Small aesthetic impact
Moderate	Some of community ill in relation to discharge	Minor impact for big population	Moderate aesthetic impact	Large aesthetic impact
Major	Most of community ill in as result of the discharge. (“Severe”)	Major impact of small population	Major regulatory impact	Population exposed to significant illness
Catastrophic	All of community ill as a result of discharge. At least one death (“Extreme”)	Major impact of big population	Catastrophic public health impact	Death expected from exposure

Table E.7 Environmental Consequence Ratings and Descriptors from literature (for environmental effects resulting from treated wastewater discharge)

Consequence rating	Descriptor: Environment	
	(EPA Victoria, 2021)	(Roper-Lindsay, et al., 2018) (Table 8)
Insignificant	No negative impact	(Negligible magnitude) Very slight change from the existing baseline condition. Change barely distinguishable, approximating to the ‘no change’ situation; AND/OR Having negligible effect on the known population or range of the element/feature
Minor	Harmful to local ecosystem with local impacts contained to site	(Low magnitude) Minor shift away from existing baseline conditions. Change arising from the loss/alteration will be discernible, but underlying character, composition and/or attributes of the existing baseline condition will be similar to pre-development circumstances or patterns; AND/OR Having a minor effect on the known population or range of the element/feature
Moderate	Harmful to regional ecosystem with local impacts primarily contained to on-site	Loss or alteration to one or more key elements/features of the existing baseline conditions, such that the post-development character, composition and/or attributes will be partially changed; AND/OR Loss of a moderate proportion of the known population or range of the element/feature
Major	Lethal to local ecosystem; pre-dominantly local, but potential for off-site impacts	(High magnitude) Major loss or major alteration to key elements/features of the existing baseline conditions such that the post-development character, composition and/or attributes will be fundamentally changed; AND/OR Loss of a high proportion of the known population or range of the element/feature
Catastrophic	Lethal to regional ecosystem or threatened species; wide-spread on-sit and off-site impacts	(Very high magnitude) Total loss of, or very major alteration to, key elements/features/ of the existing baseline conditions, such that the post-development character, composition and/or attributes will be fundamentally changed and may be lost from the site altogether; AND/OR Loss of a very high proportion of the known population or range of the element/feature

Appendix F

Examples of Low, Medium, High and Critical Risk RIS

The following table is intended as a prompt for users of the RIS Standard. The examples are not exhaustive and are purposely broad, as each individual site should be assessed and evaluated on a case-by-case basis by a suitably qualified and experienced practitioner.

Table F.8 Examples of RIS Attributes

Risk	RIS Example Attributes
Low	– Detailed level of site knowledge/ Investigation. – Good compliance record for environmental monitoring. – Highly suitable and well characterised, soil type. – Well characterised groundwater of good quality and with no receptors. – Down-gradient drinking water wells screened within the impacted aquifer are located outside the Source Protection Zone. – Generous land area available that allows for contingency and not close to receiving surface water. – No food crops or stock grazing directly on application zone. – No risk of flooding or effects of sea level rise – High confidence with adequate groundwater separation – No existing contamination concerns based on existing site monitoring data. – Clear and effective operation and maintenance practice.
Medium	– Moderate level of characterisation supported by site investigation and monitoring data. – Acceptable soil type. – Occasional low permeability soil layers present but not laterally extensive. – Seasonal high-water table of 5 m depth below discharge invert after accounting for groundwater mounding – One domestic down-gradient drinking water well screening the impacted groundwater. – No nearby springs. – Elevated area, minor risk of flooding.
High	– Limited site investigation data and monitoring data. – Heterogenous Soil characteristics. – Low permeability soil layers present, some laterally extensive. – Water table response to river and rainfall with water levels sometimes reaching 2 m below ground level. – Moderate number of down-gradient drinking water wells screening the impacted groundwater. Some show increasing trends in nitrate-nitrogen and pathogens. – One local spring discharge 100 m down-gradient of the wastewater discharge that periodically flows into an adjacent surface water body. – Land has experienced past flooding due to tidal storm surges. – High value farming land-use near the discharge. – Some historical issues with clogging and RIS system performance.
Very High	– Very limited site investigation data and monitoring data. – Laterally extensive limiting layer(s) of low permeability soil. – Rapid water table response to rainfall with water levels sometimes reaching 0.5 m below ground level. – Large number of down-gradient drinking water wells screening impacted groundwater. – Local springs near wastewater discharge that flow into a hydraulically connected surface water body located less than 50 m away. – High-water table close to ground surface with periodic water logging in winter.