Sensitivity: General

Beca

Lake Waikare - Water Quality Effects Assessment

Te Kauwhata Wastewater Treatment Plant

Prepared for Watercare Services Ltd
Prepared by Beca Limited

19 February 2025

Contents

Revision History

Revision Nº	Prepared By	Description	Date
1	Anna Kostiuk-Warren	For Client Review	7/02/25
2	Anna Kostiuk-Warren	Final	19/02/25

Document Acceptance

Action	Name	Signed	Date
Prepared by	Anna Kostiuk-Warren	pp	19/02/25
Reviewed by	Gemma Wadworth		19/02/25
Approved by	Garrett Hall		19/02/25
on behalf of	Beca Limited		

Executive Summary

The Te Kauwhata Wastewater Treatment Plant (WWTP) has historically not complied with its discharge consent, which, as well as affecting water quality values, has also affected community and cultural perception of the discharge. This has been exacerbated by the hypertrophic state of the receiving environment, Lake Waikare, although previous work by Beca has shown that its state has primarily been caused by the effects of the Lower Waikato flood control scheme, catchment land uses and the loss of macrophyte beds.

Overall, the receiving environment has very poor water quality as evidenced by sampling and long-term monitoring.

To comply with its consent and prepare for future increased flows in line with population projections, Watercare has examined the best options for the plant discharge and has also installed a significant upgrade (MABR/MBR) that have brought all water quality measures in line with the existing consent conditions.

These upgrades led to a significant improvement in discharge quality, bringing all monitoring results within consent limits since the upgrades were installed in late 2023.

Sampling undertaken for this investigation has shown that the MABR/MBR discharge quality is of a higher quality than the Lake Waikare, with the only exception being for phosphorus, which shows no observable effects in the discharge channel, compared to the background Lake water quality.

A long-term assessment has also been undertaken and shows that the WWTP can provide for population growth through to 2050, with proposed treatment limits ensuring that the ultimate 2050 nitrogen and phosphorus loads to the Lake remain below pre-MABR upgrade levels.

Overall, the improvements to the WWTP discharge contribute to the overall betterment of Lake Waikare consistent with Plan Change 1 (PC1) of the Waikato Regional Plan and Te Ture Whaimana o te Waikato The Vision and Strategy for the Waikato River.

1 Introduction

Beca Ltd (Beca) has been engaged by Watercare Services Limited (Watercare) to prepare a Water Quality Effects Assessment (WQA) for the discharge of treated wastewater to Lake Waikare from the Te Kauwhata Wastewater Treatment Plant (WWTP. The treated wastewater originates from the surrounding township and is subsequently treated before discharge to the receiving environment. The WWTP is owned by Waikato District Council (WDC) and is operated and maintained by Watercare.

The current resource consent (117991) held by WDC, permitting the discharge of treated wastewater from the WWTP to Lake Waikare, is due to expire on 4 July 2028. A new long-term discharge solution is to be determined through an optioneering process which is currently being undertaken by WDC and Watercare in consultation with tāngata whenua and stakeholders.

An enhancement of the existing discharge to the unnamed channel of Lake Waikare is one of three short list options being considered for the long-term discharge solution. This WQA has been prepared to support the options assessment for the proposed enhanced lake discharge option in the existing location. If that option is progressed, the WQA could also be used to support a resource consent application for the enhanced discharge option.

The proposed discharge 'enhanced discharge' option includes treatment from a new Membrane Aerated Bioreactor (MABR) / Membrane Bioreactor (MBR) treatment process which became operational in December 2023, and landscape and ecological enhancement planting adjacent to the WWTP site.

1.1 Scope and Objectives

The scope of the WQA includes the following:

- A review of the existing WWTP process details, treatment capacity/population estimates, and proposed future upgrades.
- A review of the receiving environment information, including analysis of existing available water quality data for Lake Waikare and water quality results for samples collected from downstream of the discharge into the unnamed stream channel.
- A review of the treated wastewater discharge characteristics of the existing and predicted future discharge with respect to key water quality parameters and flow rate, including comparison of discharge parameters pre and post the 2023 MABR installation.
- Review of existing available information and modelling regarding catchment land use and relative nutrient load contributions from the treated wastewater discharge to Lake Waikare.
- An effects assessment based on the above against the Operative Plan Waikato Regional Plan (WRP) and Proposed Plan Change 1 (PC1) to the WRP, with particular focus on the relative contribution of nutrient from the WWTP discharge to Lake Waikare, and continued long term improvement above and beyond pre MABR discharge.

1.2 Assessment Criteria

This assessment references the objectives and addresses the information requirements of policies relevant to water quality effects under the Operative WRP and PC1. The assessment also addresses Section 107 of the Resource Management Act 1991 (RMA). These are described in the following sections.

1.2.1 Operative Waikato Regional Plan (WRP)

1.2.1.1 Information requirements: Discharges

When applying for a resource consent to discharge, section 8.1.2.5(i) of the WRP states that the effect the discharge will have on the receiving environment must be assessed, including the effect on the purpose(s) of relevant water management classes as set out in section 3.2.3 of the Plan.

1.2.1.2 Policies: Water Management Classes

The discharge channel from the WWTP does not have any water management class recognition based on the Waikato Regional Council Geomaps Water Classification layers. Lake Waikare has the following water management classes:

- Surface water;
- Contact recreation
- Indigenous Fish Habitat
- Priority 1 Stock Exclusion Class

Section 3.2.3 of the WRP, Policy 4 – 'Waikato Region Surface Water Class', states:

The use of surface water bodies in the Region is enabled provided that any significant adverse effects on existing aquatic ecosystems are avoided, remedied, or mitigated;

- Intake structures are designed to minimise fish entrapment.
- Any conspicuous change in visual colour or clarity is avoided, remedied or mitigated.
- The water body is not tainted or contaminated to the extent that it is unpalatable or unsuitable for consumption by humans after treatment (equivalent to coagulation, filtration and disinfection).
- The water body is not tainted or contaminated to the extent that it is unpalatable or unsuitable for consumption by humans after treatment (equivalent to coagulation, filtration and disinfection).

Policy 6 – 'Contact Recreation Water Class', states:

Water bodies with significant contact recreation uses must maintain a safe water quality environment by;

- Avoiding reductions in clarity that make the water unsuitable for contact recreation.
- Avoiding contamination to levels that represent a significant risk to human health or to levels that would render the water body unsuitable for contact recreation.
- Avoiding the development of bacterial and/or fungal growths that are visible to the naked eye.
- Avoiding the development of periphyton growths or mats to the extent that they cover more than 25% of the bed of the water body.

Policy 7 – 'Fishery Class', states that

- Reaches of the Waikato River (main stem) that support a diverse range of fish species and fish habitats, or which support significant recreational, traditional, or commercial fisheries must maintain (or enhance) existing water quality and aquatic habitat by;
  - Minimise adverse effects of sediment loads and other contaminants on fish or their habitat;
  - Maintain water temperatures and dissolved oxygen levels that are suitable for aquatic habitat;
  - Ensure fish living in these waters are not rendered unsuitable for human consumption by the presence of contaminants; and
  - Minimise the adverse effects of physical disturbance to aquatic habitat.

1.2.2 Waikato Regional Plan: Proposed Plan Change 1

At the time of writing the decisions version of PC1 to the WRP has been notified. A number of appeals have been lodged. Accordingly, the decisions version of PC1 (April 2020) may be subject to change as a result of the appeals process. Notwithstanding this, the following section provides a brief overview of the relevant objectives and policies for this water quality assessment (referencing the decisions version of PC1).

1.2.2.1 Objectives

- Objective 1/Te Whāinga 1:
    - In relation to the effects of nitrogen, phosphorus, sediment and microbial pathogens on water quality, the health and wellbeing of the Waikato and Waipā Rivers (and all water bodies in their catchments) is both restored over time and protected so that they are safe for people to swim in and take food from by 2096.
- Objective 2 (Freshwater Objective)/Te Whāinga 2 (Te Whāinga Wai Māori):
    - Progress is made over the life of this Plan towards the restoration and protection of the health and wellbeing of the Waikato and Waipā River catchments in relation to nitrogen, phosphorus, sediment and microbial pathogens by the short term numeric water quality values in Table 3.11-1 being met no later than 10 years after Chapter 3.11 of this Plan is operative.

1.2.2.2 Policies

- Policy 12/Te Kaupapa Here 12:
    - Proposed point source discharges of nitrogen, phosphorus, sediment or microbial pathogens to water or onto land in the Waikato or Waipā River catchments must represent the Best Practicable Option (at the time) to prevent or minimise any adverse effects.
    - Where residual adverse effects remain, remediation measures should be proposed at an alternative location to offset negative effects.
    - For the purpose of establishing if a discharge will have a residual adverse effect, relevant considerations include:

        a. The extent to which any replacement discharge(s) fails to reduce the contaminant load of an existing discharge proportionate to the decrease required to achieve the short term numeric water quality values in Table 3.11-1 or the steady progression towards the 80-year water quality attribute states in Table 3.11-1; and

        b. In respect of a new discharge, whether any new discharge will increase the load of nitrogen, phosphorus, sediment and/or microbial pathogens contaminants to either the Waikato River or Waipā River catchments.
- Policy 13/Te Kaupapa Here 13:
    - Proposed point source discharges of nitrogen, phosphorus, sediment or microbial pathogens to water or onto land in the Waikato or Waipā River catchments must consider the contribution made to the nitrogen, phosphorus, sediment and microbial pathogen loads in the Waikato River or Waipā River catchments and the impact of that contribution on the achievement of the short term numeric water quality values in Table 3.11-1 and, where applicable, the steady progression towards the 80-year water quality attribute states in Table 3.11-1, taking into account the following:

        a. The contribution of nitrogen, phosphorus, sediment or microbial pathogens as a proportion to the catchment load and the net change proposed in that contribution; and

        b. The water quality of the receiving environment and how the proposed discharge will contribute to the improvement in water quality in a manner proportional to the impact of the discharge (where the receiving environment is less than high quality).

        c. Where relevant, reduction in the discharge of nitrogen, phosphorus, sediment or microbial pathogens within the previous consent term resulting from past plant upgrades.

With respect to point source discharges, the following policies apply:

- Policy 15/ Te Kaupapa Here 15:
  - Contribute to restoration and protection of riverine and peat lakes by:

    a. The reduction of both diffuse and point source discharges of nitrogen, phosphorus, sediment and microbial pathogens entering the catchments of those lakes consistent with achievement of the numerical water quality values for lake Freshwater Management Units in Table 3.11-1; and

    b. The implementation of a tailored lake-by-lake approach, guided by existing data and information and any existing Lake Catchment Plans as well as Lake Catchment Plans prepared over the next 10 years, which will include collecting and using data and information to support improving the management of land use activities within the lakes Freshwater Management Units.
- Policy 16/Te Kaupapa Here 16:
  - Contribute to restoration and protection of the Whangamarino Wetland by the reduction of both diffuse and point source discharges of nitrogen, phosphorus, sediment or microbial pathogens entering the wetland system, to:

    a. Achieve the numeric water quality values and attribute states in Table 3.11-1 for Whangamarino Wetland Catchment area sub-catchments shown in Map 3.11-3;

    b. Assist protection of the significant values and ecosystem health of the wetland system;

    c. Minimise further loss of bog wetland habitat;

    d. Increase the availability of mahinga kai;

    while taking account of the hydrological drivers that affect water quality.

1.2.3 Resource Management Act Section 107

Section 107 of the RMA states that a discharge is not allowed if the discharge (either by itself or in a combination with the same, similar or other contaminants or water), after reasonable mixing, results in:

- The production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
- Any conspicuous change in the colour or visual clarity;
- Any emission of objectionable odour;
- Any significant adverse effects on aquatic life.

1.3 Lake Waikare Catchment Analysis Report

This previous report prepared as part of this project[1], focussed analysis focussed on water quality issues on a catchment scale, and how historical changes may have influenced the current state of the Lake. Ecological components of the Lake system and how they are impacted by water quality were described. Key drivers of ecological impacts and opportunities for ecological betterment were also identified.

Ecologically, the Lake is considered to have medium to high ecological values due to the confirmed presence of several At Risk and Threatened native fauna species, although the fish population is dominated by pest species.

---

[1] Beca, (2004). Lake Waikare Catchment Analysis: Desktop Assessment of Contributing Catchments, Ecology and Water Quality. Prepared for Watercare Services Ltd.

The Lake once supported a macrophyte bed, but this collapsed in the 1970s and has never recovered. Diversity in the ecosystem is largely hindered by the poor water quality and other abiotic factors such as wind and wave mixing and temperature.

A review of aerial photography showed that over 80% of Lake Waikare's catchment falls within agricultural land use type, with the more intensive activities (such as cropping and dairy farming) occurring on low land around the lake's margins, and that between 1943 and 2021 there was significant reduction in the extent of riparian vegetation and slight changes in shoreline morphology. The intensification of farming activities coupled with a reduction in buffer vegetation, likely led to a consistent increase in nutrient and sediment laden runoff into the lake compared to its unmodified state.

The effects of the lake's lowering as part of the Lower Waikato/Waipa Flood Scheme was also summarised. To control the effects of flooding in nearby farmland and transport routes, a gate was installed at the Lake's outlet in 1953 to manipulate its water level depending on seasonal fluctuations but generally keeps the Lake's water level within 0.3m. The strict hydraulic control significantly reduced the ability of the Lake to stratify, thus keeping it in a constant state of mixing, preventing settlement of sediment and light penetration. It was determined that the hydraulic modification was one of the strongest factors in the reduction in water quality and sealed the collapse of the macrophyte beds.

The wastewater discharge from the Te Kauwhata WWTP was also summarised in the catchment analysis. The WWTP was historically in breach of its discharge consent, regularly exceeding nutrient and *E.coli* limits. A literature and data review of publicly available and client provided information was completed. This included a conference paper, by T Cox and J Cooke (2014), which investigated strategies for flushing Lake Waikare with water from the Waikato River and how this may impact water quality in the Lake. As part of their water quality model, they included wastewater discharge data. The model indicated that the likely contribution of nutrients from the WWTP was 1.3t/y and 0.8t/y for nitrogen and phosphorus, respectively, with the total catchment load to the lake at 96t/y (nitrogen) and 578t/y (phosphorus). This indicated the low nutrient contributions to the Lake from the WWTP when compared to the wider catchment.

When all aspects of the Lake's catchment were considered together, it was clear that several were strongly interlinked. The removal of riparian vegetation, intensive farming, and the flood scheme were all considered to be the key drivers of the collapse of the macrophyte beds. Consequently, nutrients accumulated rapidly and became bound to sediment that could not settle due to constant mixing. This facilitated poor ecological outcomes and the loss of biodiversity, hastened by the infestation of pest fish.

Sitting outside of this is the discharge from the WWTP. No clear linkages from the discharge to poor water quality outcomes was identified. This is supported by modelling showing likely low contribution from the discharge to overall loads of nitrogen and phosphorus to the lake. Therefore, to meaningfully restore the Lake, intensive catchment management is required, including the reestablishment of riparian margins and restoration of macrophytes. It was concluded that improvement in the wastewater discharge quality will undoubtedly have localised positive effects but is unlikely to significantly contribute to observable long term positive water quality outcomes for the whole Lake.

2 Description of the Wastewater Scheme

2.1 Discharge Consent Summary

The existing discharge consent was issued in 2013 and expires in 2028. Key aspects of the consent with respect to the discharge parameters are summarised below:

- Maximum volume of treated wastewater to not exceed 3,600 m^3/day and the annual average shall not be more than 1,100 m^3/day.
- The discharge must comply with the following limits (Table 1):

Table 1: Discharge consent limits.

Parameter	Median limit	90th Percentile Limit
Five-day Biochemical Oxygen Demand (cBOD5)	10 g/m^3 (90th percentile)	20 g/m^3
Total Suspended Solids	15 g/m^3 (90th percentile 25 g/m^3)	25 g/m^3
Total Kjeldahl Nitrogen (TKN)	6 g/m^3 (90th percentile 12 g/m^3)	12 g/m^3
Total nitrogen (TN)	8 g/m^3	N/A
Total nitrogen load (TN_{load})	8.8kg/day	N/A
Total phosphorus (TP)	5.6g/m^3	N/A
Total phosphorus (TP_{load})	3.1kg/day	N/A
Echerichia coli (*E.coli*), 12m period*	1500 MPN/100ml	N/A

For the purposes of the *E.coli*, to determine compliance with the median limits (excluding *E.coli*), no more than six samples in any 12 consecutive monthly samples over the period 1 July to 30 June each year shall exceed the specified limit. To determine compliance with the median *E.coli* limit, no more than 13 samples in any 26 consecutive weekly samples shall exceed the specified limit. To determine compliance with the 90th percentile limits, no more than one sample in any ten consecutive monthly sampling events shall exceed the specified limit.

2.2 Previous Wastewater Treatment Process and Performance

2.2.1 Previous Treatment Process

Prior to the MABR upgrades, the wastewater treatment plant process comprised inlet screens, two aerated ponds with aquamats, wetlands and a rock filter prior to discharge to the Lake [2].

2.2.2 Non-Compliance Issues

The Te Kauwhata WWTP has had historical problems complying with its discharge consent, due to the increase in population within the plant's catchment causing a reduction in the plant's performance. In particular, *E.coli*, nitrogen and phosphorus had consistently exceeded consent limits.

Beca was provided with an annual report of discharge compliance for the 2018-2019 and 2019-2020 period. For 2018-2019, the report noted four exceedances for both median and 90th percentile (where applicable) limits for nutrients, total suspended solids and *E.coli.* For the 2019-2020, eight exceedances were noted,

[2] Site Compliance Report 7 October 2020.

which included $cBOD_5$, and total suspended solids as well as nutrients and *E.coli*. Other consent conditions, relating to investigation of alternative discharge options and flow data have not had compliance problems.

Outside of the consent, the WWTP has also faced criticism from local iwi as the discharge to the Lake is seen as culturally unacceptable. The ongoing non-compliance has also received media attention in the past, where it has been reported alongside the water quality problems of Lake Waikare.

2.2.3 Historic Mass Loads Discharged

Mass loads of the nutrients nitrogen and phosphorus were calculated for years 2020-2023 (prior to upgrades) using average daily outflow from the WWTP (Figure 1). For years 2020-2022, nitrogen was averaging between 25-30kg/day, and phosphorus between 3.5-6kg/day.

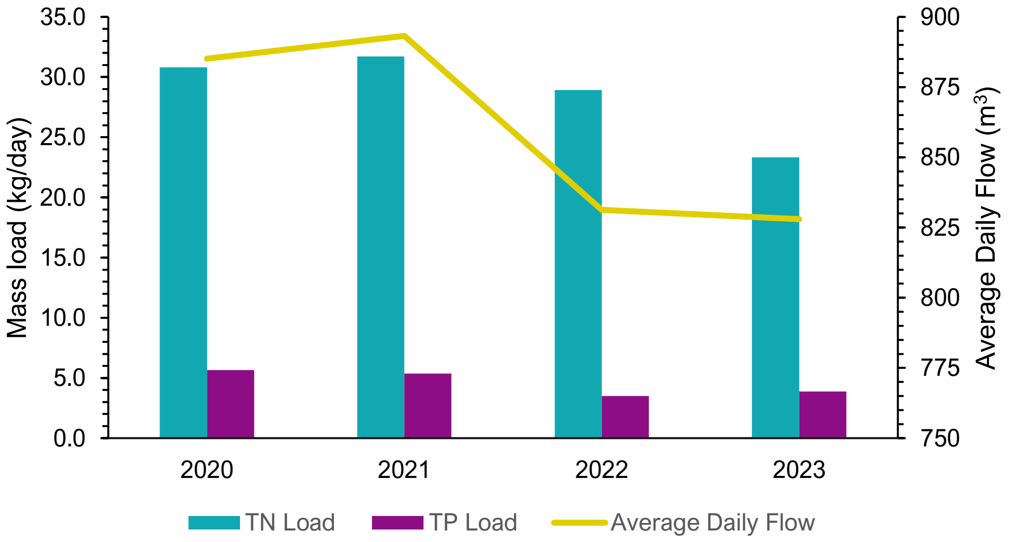

Figure 1: Historical nitrogen and phosphorus mass loads (average daily flow).

Table 2 below summarises the average total nitrogen and phosphorus loads for years 2020-2023, where the WWTP was regularly exceeding compliance limits. This serves as a baseline for comparison to post upgrade values, discussed in Section 5.2.

Table 2: Average Discharge Nutrient mass Loads 2020 - 2023

Mass Load	Average (2020-2023)
Total nitrogen	28.7 kg/day
Total phosphorus	4.6 kg/day

2.3 Upgraded Wastewater Treatment Process

Watercare provided Beca with the Process Flow Diagram (PFD) and associated details for the MABR / MBR treatment upgrade commissioned in December 2023. The overall PFD is provided below in Figure 2. The process elements are summarised below:

1. **Influent Screening** to filter out debris from incoming wastewater.
2. **Biological treatment** to break down organic pollutants. This stage includes the MABR, followed by bulk aeration combined with downstream anoxic zones to target nitrogen removal. Alum dosing targets phosphorus removal.
    a. The MABR uses airflow through fibres suspended in the wastewater to support biofilm growth for efficient nitrogen removal. The control targets a reduced oxygen level (anoxic) so

that an oxygen gradient forms across the active biofilm. This enables the different microorganisms to be closely coupled and undertake both nitrification and denitrification.

b. Aeration bubbles lift the oxygen level with recirculated flow, supporting microorganism growth and nitrification within the activated sludge. This sets up the next stage, denitrification where the bulk solution targets an anoxic environment.

3. **Membrane bioreactor (MBR)** where a semi-permeable membrane filters water from activated sludge. The membrane fibres target suspended solids and pathogen removal to produce a discharge with high clarity.
4. **Ultraviolet (UV) treatment** is the final treatment stage to treat harmful pathogens such as bacteria and viruses.
5. **Upturned bell mouth with eel screen** for discharge. Discharge quality and flow monitoring occurs immediately prior to this point.

The **oxidation ponds** have been retained in place to buffer storm events where stormwater inflows in excess of the MABR capacity are directed to the oxidation ponds. Following a storm event, excess flow retained in the ponds is typically returned to the MABR / MBR process once there is free process capacity. However, occasionally when the storage capacity of the ponds is exceeded some flow may be discharged from the ponds through the wetlands before combining with the MABR treatment stream prior to UV disinfection. Therefore, on these occasions a blended flow is discharged to the receiving environment.

Since the WWTP began operation in December 2023, it is still in the process of being optimised through wet weather events. Therefore, there is not yet a finalised estimate of frequency of the blended flow discharge. However, based on operation of the WWTP to date, it is expected that approximately 5 – 10 blended discharge events could happen per year.

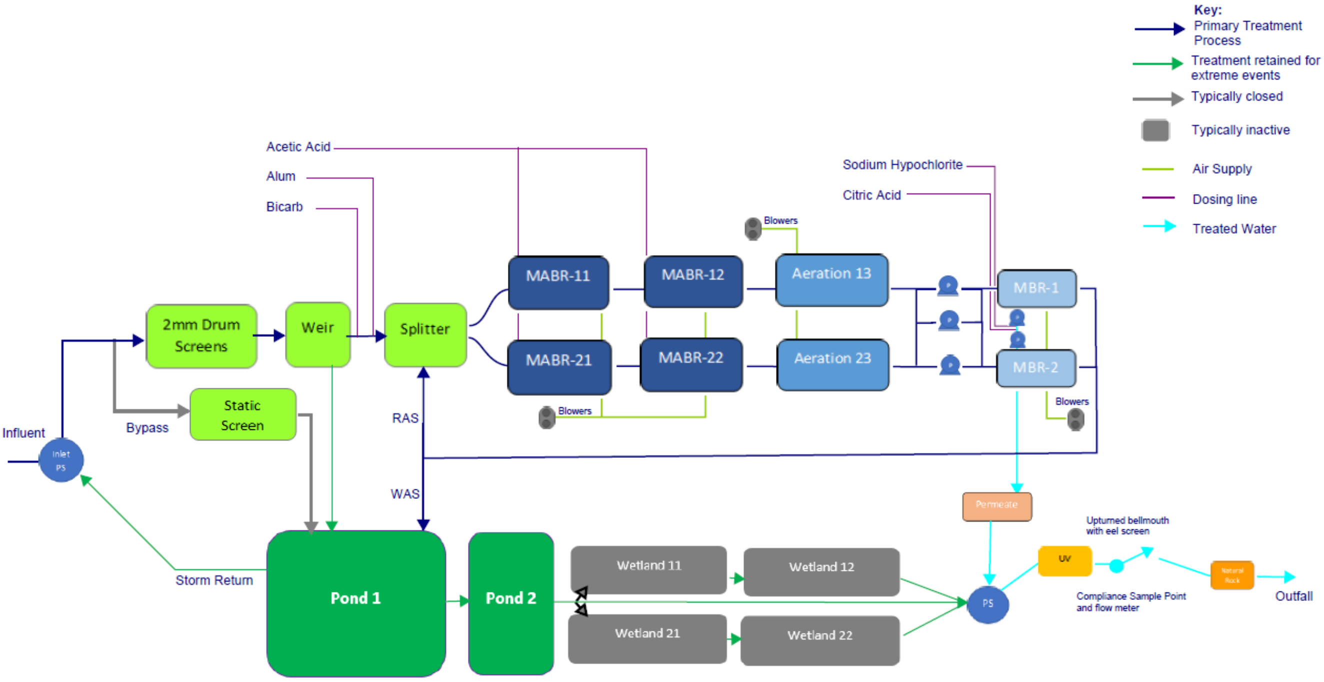

Figure 2: Process flow diagram for the upgraded Te Kauwhata WWTP

2.4 Future Proposed Upgrades

The MABR is currently a dual lane which has capacity to cover a population equivalent (PE) of up to 6,400. Watercare based process treatment performance estimates based on an average dry weather flow for the single lane of 1,500 m^3/day for a dual lane up to the 6,400 PE. The third lane is expected to be added in 2028/2029 (as per the current WDC Long Term Plan).

Additional capacity will be added in the future as populations increase.

2.5 Future Population Projections

A summary of the predicted future population and average daily flows is presented below in Table 3.

Table 3: Flow Projections

Estimate Source	Population Estimate (2050)	Average Daily Flow Estimate m^3 (2050)
Mid-Waikato Strategy Projection (Based on Table 2-1 Mott McDonald, Stantec, 2020)	18,821	5,052

As noted in Section 2 there are anticipated to be 5 – 10 blended wet weather flow events per year. As plant optimisation progresses, the frequency and size of the overflows will become more certain.

2.6 Proposed Consent Limits

Table 4 below summarises the proposed consent limits for any potential future Enhanced Lake Discharge option. For this, values less than the average of loads prior to the upgrades are suggested.

Table 4: Proposed Future Consent Limits for Potential Lake Waikare Enhanced Discharge

Parameter	Unit	Median Limit	Average Limit	90^{th} Percentile Limit
$cBOD_5$	mg/L	10	N/A	20
TSS	mg/L	10	N/A	20
TN	kg/day (annual)	N/A	20	N/A
TP	kg/day (annual)	N/A	4.5	N/A
E. coli	cfu/100mL	50	N/A	130

3 Receiving Environment

3.1 Catchment Characteristics

The WWTP discharge enters Lake Waikare via an approximately 400 m long channel (known hereafter as the "discharge channel" which runs between Rimu Street and a patch of wetland vegetation to the west of the WWTP oxidation ponds (Figure 3). Lake Waikare is a shallow riverine lake (Matahuru catchment size 210km^2), with several inlets (one of which is gate controlled) and one outlet into Pungarehu Stream. Pungarehu Stream then discharges into the Whangamarino River, located within the Whangamarino wetland. The Whangamarino river discharges into the Waikato River near Mercer.

Figure 3: Discharge channel

Lake Waikare's catchment characteristics are described in detail in the Lake Waikare Catchment Analysis assessment prepared in January 2024. Key aspects are summarised below:

- The Lake is in a hypertrophic state with poor water quality values.
- Lake water levels were lowered as part of the Lower Waikato/Waipa Flood Control Scheme to reduce flooding on land and transport infrastructure.
- 83% of the catchment comprises agricultural land use, with more intensive practices (i.e. dairy and crop cultivation) occurring on the low, flat areas of land near the lake margins.
- Riparian vegetation coverage has reduced and/or fragmented between 1943 and 2021.
- Lake Waikare has medium to high ecological value due to the recorded presence of At Risk and Threatened native fauna species. No macrophytes are present in the lake.

The discharge channel does not exclusively carry discharge from the WWTP. Two additional tributaries feed into the channel from the west (0.78km^2 catchment), southwest (0.33km^2 catchment) - both draining farm land[3]. A third tributary/overland flow path from the north (0.7km^2 catchment) drains water from Te Kauwhata.

[3] Catchment sizes derived from NIWA River Flood Statistics (https://niwa.maps.arcgis.com/apps/webappviewer/index.html?id=933e8f24fe9140f99dfb57173087f27d)

At the point of its exit into Lake Waikare, the channel drains a total of 2.03km^2, not inclusive of discharge from the WWTP.

3.2 Discharge Channel

3.2.1 Sampling methodology

There is limited existing information about the water quality of the discharge channel. Therefore, a site visit was completed on 10th October 2024 to collect water quality samples from the discharge channel. Three accessible locations were selected for sampling, shown in Figure 4.

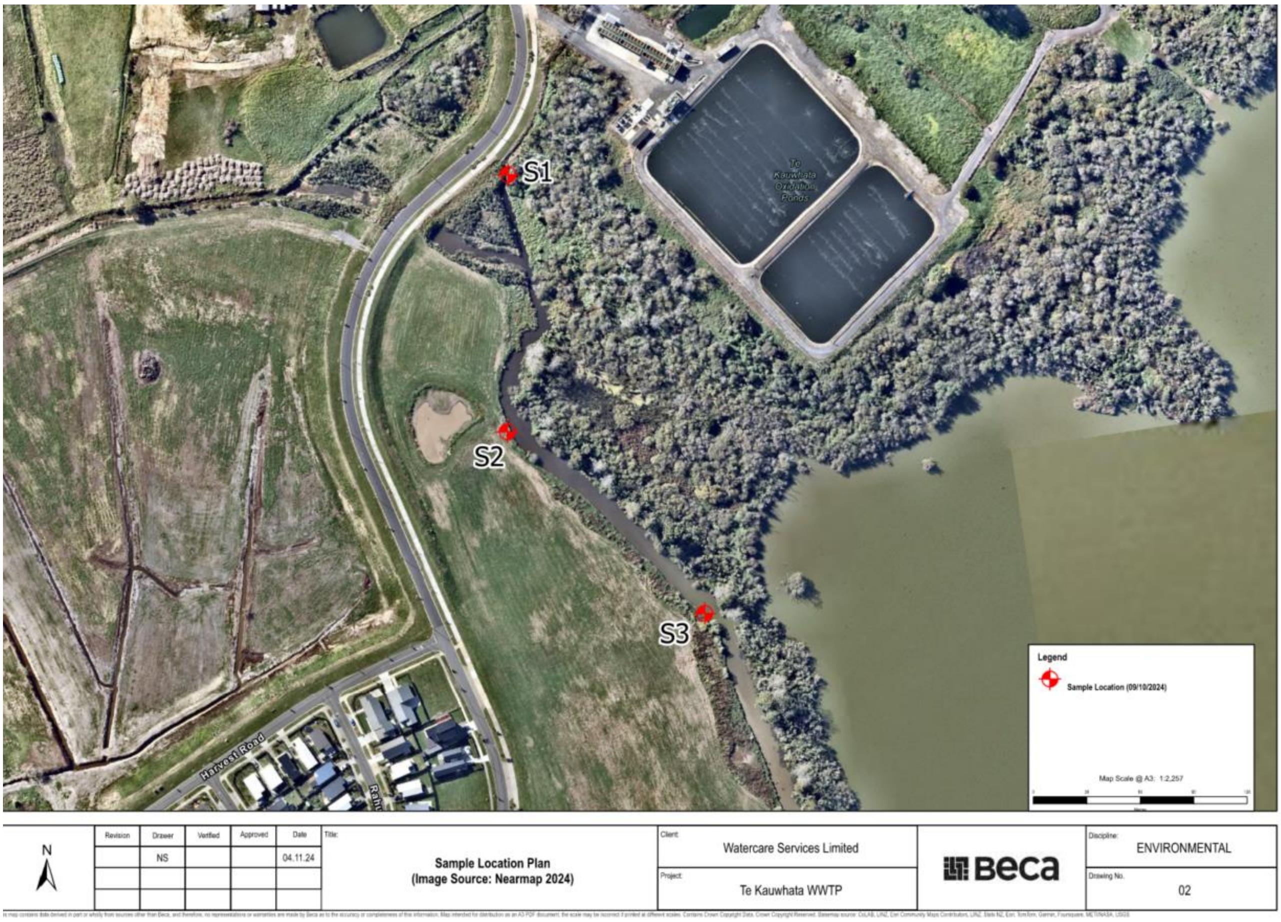

Figure 4: Sample Location Plan

Location S1 is downstream of the treated wastewater discharge and upstream of a confluence of the discharge channel and an unnamed tributary and is likely to be directly influenced by the treated wastewater discharge. The S1 location was initially planned to be collected further upstream closer to the WWTP, however this was not possible due to accessibility issues. Location S2 and S3 are approximately 34m and 184m downstream of the confluence with the unnamed tributary, respectively. Location S3 is near the mouth of the discharge channel prior to Lake Waikare.

Given only one round of sampling has been undertaken, and an upstream sample location was not accessed, the results provide an indication of water quality conditions in the discharge channel only.

At each location, surface water quality information was collected via YSI ProPlus probe and water samples were obtained using a grab sampler for laboratory analysis. The following parameters were selected to be analysed (Table 5):

Table 5: Water quality parameters measured.

YSI ProPlus Probe	Laboratory Analysis
Temperature	Total Suspended Solids (TSS)
Dissolved Oxygen	Total Nitrogen
Specific Conductivity	Total Ammoniacal-N
Total dissolved solids (TDS)	Nitrite-N
pH	Nitrate-N
Turbidity	Nitrate-N + Nitrite-N
	Total Kjeldahl Nitrogen (TKN)
	Dissolved Reactive Phosphorus
	Total Phosphorus
	Carbonaceous Biochemical Oxygen Demand (cBOD5)
	Escherichia coli (*E.coli)*
	Chlorophyll a

For laboratory samples, clean gloves were worn for the collection of each sample. All samples were submitted with ice packs in an insulated container, with an accompanying chain of custody form. Samples were delivered to Hill Laboratories, Hamilton on the same day.

Reported sample temperature was >11.5°C. The laboratory noted that this may affect the reliability of *E.coli* results. cBOD5 analysis could not be completed on the same day, it was instead undertaken on the frozen samples later.

3.2.2 Results

Water quality information was assessed against the Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2018 (ANZG) [4] default water quality guidelines for physical and chemical stressors of ecological health and the WRC River Water Quality monitoring standards for ecological health[5] and contact recreation[6] (Table 3). Recommended nitrate toxicity guidelines have been updated since the release of the 2018 guidelines; the ANZG value given in Table 6 is the grading nitrate concentration for 95% species protection in the updated 2013 guidance released by NIWA[7]. Exceedances are shown in **bold text,** with WRC categories shown in *italic text* where applicable.

[4] ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. www.waterquality.gov.au/anz-guidelines. Accessed 30 October 2024

[5] Waikato Regional Council (2021) River water quality for ecological health (Table 2). https://www.waikatoregion.govt.nz/environment/water/river-and-stream-monitoring/indicator-river-water-quality-ecological-health/. Accessed 30 October 2024.

[6] Waikato Regional Council (2021) River water quality for contact recreation (Table 2). https://www.waikatoregion.govt.nz/environment/water/river-and-stream-monitoring/indicator-river-water-quality-contact-recreation. Accessed 30 October 2024.

[7] National Institute of Water and Atmospheric Research Ltd (NIWA) (2013) Updating nitrate toxicity effects on freshwater aquatic species.

Table 6: Assessment of discharge channel against ANZG (2018) Guidelines and WRC River Ecological Health and Contact Recreation Standards.

Parameter	ANZG Default Guideline	Sample Location		
		S1	S2	S3
Dissolved Oxygen % 20th percentile	82	**65** *unsatisfactory*	**48** *unsatisfactory*	**70.9** *unsatisfactory*
pH 20th percentile	7.27	**7.21** *excellent*	**7.13** *excellent*	7.3 *excellent*
Turbidity (NTU) 80th percentile	4.2	**5** *satisfactory*	**36** *unsatisfactory*	**46** *unsatisfactory*
Suspended Solids (mg/L)	4.6	4	**38**	**71**
Conductivity (µS/cm) 80th percentile	86	**524**	**359**	**270**
Total nitrogen (g/m^3) 80th percentile	0.281	**2.7** *unsatisfactory*	**1.7** *unsatisfactory*	**2.7** *unsatisfactory*
Total ammoniacal N (g/m^3) 95% species protection	0.9	**0.98** *unsatisfactory*	0.28 *unsatisfactory*	0.10 *unsatisfactory*
Nitrate (g/m^3) 95% species protection	2.4	0.72	0.6	0.35
Dissolved Reactive Phosphorus 80th percentile (g/m^3)	0.007	**0.17**	**0.08**	**0.01**
Total phosphorus (g/m^3) 80th percentile	0.023	**0.26** *unsatisfactory*	**0.21** *unsatisfactory*	**0.31** *unsatisfactory*
Temperature (°C)	N/A	16.0 *satisfactory*	15.2 *excellent*	16.6 *satisfactory*
E.coli 95th percentile (MPN/100ml)	N/A	548 *satisfactory*	866 *unsatisfactory*	1203 *unsatisfactory*

For ANZG (2018) guidelines, conductivity, dissolved reactive phosphorus, and dissolved oxygen concentrations were above the guidelines at all the sampling points. Nitrate at all sampling points was within guidelines, and only sample S1 was below the standard for suspended solids. Samples S1 and S2 were slightly above the 20th percentile guideline for pH, but well below the 80th percentile guideline. Samples S2 and S3 were within guidelines for total ammoniacal N, sample S1 exceeded the guideline by 0.08g/m^3.

For WRC River categories, all samples were “unsatisfactory” for dissolved oxygen and nutrient parameters. All samples were “excellent” for pH. Sample S1 was “satisfactory” or “excellent” for four parameters.

Considering both WRC categories and ANZG (2018) guidelines, the sample results indicate that the channel has poor water quality.

A replicate laboratory sample of sample S2 was collected for QA/QC purposes. The Relative Percentage Difference (RPD) between the samples ranged from 1.25-16%, aside from TSS and *E.coli* which had RPDs of 66%.

3.3 Lake Waikare Regional Monitoring

Lake Waikare has had a historic hypertrophic status, with consistently poor water quality. Several factors have contributed to this over the past 50 years, these are described below.

- Clearance of riparian vegetation and the intensification of farming within the Lake's floodplains, increasing sediment and nutrient runoff.
- Hydraulic control of the lake outlet, resulting in an average depth of 1.5m and fluctuation up to 0.35m. This promoted mixing in the water column and the subsequent death of macrophytes due to the reduction of clarity and temperature increases.
- Macrophytes have never reestablished, and thus stabilisation of sediment and uptake of nutrients could not occur. Frequent algal blooms have occurred.
- Reduction of food sources for avifauna and native fish, allowing infestation of pest species.

All of these factors are strongly interlinked and cannot individually be identified as a singular reason for the cause of the Lake's state.

Water quality data for Lake Waikare (2019-2024) was sourced from Waikato Regional Council. Water quality is monitored at "Epilimnion" (37°25'49.51"S, 175°13'2.61"E) monthly which is approximately 6km south-east of the WWTP. Chlorophyll A, *E.coli*, ammonium, TN, TKN, TP and clarity are measured.

The data provided is compared against the WRC: Proposed Plan Change 1 Table 3.11(d) (riverine lake) 80-year target state attributes reproduced below in Table 7. Exceedances are in **bold text.**

Table 7: Summary of current Lake Waikare monitoring data against 80-year betterment state limits. Note: Results under detection limits were counted as a result at the detection limit.

Parameter	80-year target	Lake Waikare						
		2019	2020	2021	2022	2023	2024 (to September)	Average
Annual Median Chlorophyll-a (g/m^3)	0.012	**0.16**	**0.18**	**0.19**	**0.20**	**0.24**	**0.19**	**0.19**
Annual Maximum Chlorophyll-a (g/m^3)	0.06	**0.53**	**0.88**	**0.29**	**0.35**	**0.5**	**0.5**	**0.51**
Annual Median Ammonia (g NH_4-N/L)	0.00024	**0.019**	**0.081**	**0.011**	**0.042**	**0.182**	**0.097**	**0.055**
Annual Maximum Ammonia (g NH_4-N/L)	0.0004	**0.036**	**1.01**	**0.011**	**0.073**	**0.58**	**0.1**	**0.30**
Annual Median Total Nitrogen (g/m^3)	0.8	**5.00**	**6.02**	**5.06**	**4.46**	**3.27**	**4.28**	**4.68**
Annual Median Total Phosphorus (g/m^3)	0.05	**0.164**	**0.150**	**0.215**	**0.204**	**0.210**	**0.177**	**0.19**

Parameter	80-year target	Lake Waikare						
		2019	2020	2021	2022	2023	2024 (to September)	Average
95th percentile E. coli (E. coli/100mL)	540	30	170	164	438	302	59	194
80th percentile Cyanobacteria (biovolume mm^3/L)	1.8	**2.5**	1.59	0.76	0.59	1.0	1.74	1.36
Clarity* (m)	1	**0.14**	**0.18**	**0.15**	**0.17**	**0.13**	**0.20**	**0.16**

*Median black disc horizontal sighting range under baseflow conditions. Values presented for Lake Waikare are annual medians.

Concentrations exceeded the 80-year target attribute values for nutrients, chlorophyll, and clarity over the past six years. Cyanobacteria and *E.coli* concentrations are typically already meeting the attribute states.

E. coli concentrations at the sampling location are likely to be largely dependent on rural runoff (dairy effluent) and rainfall, which may impact the variability of the concentrations year to year.

Currently the lake does not meet the 80-year attribute values for riverine lake freshwater management units.

3.4 Whangamarino River

Lake Waikare drains to the Whangamarino River via the Pungarehu Stream at its northern end. The Whangamarino River (catchment of 800km^2) is hydrologically connected to the Whangamarino wetland, which is a wetland of international significance, and is a listed Ramsar site having outstanding biodiversity. It comprises several wetland classes including marsh, swamp, fen, and bog, and is the second largest bog and swamp complex in the North Island. Water quality in the river is measured at two sites; at its exit into the Waikato River and higher in its catchment in the east. Water quality values vary at both monitoring sites but is generally better at its discharge point.

Whangamarino River at Island Block Road (approximately 15km northwest of the lake outlet) water quality data from Land, Air, Water Aotearoa (LAWA)[8] was reviewed to understand its current state. Data for selected water quality parameters is summarised in Table 8 below, and the Plan Change 1 values have been included (adapted from WRC: Proposed Plan Change 1 Table 3.11-1(a)).

Table 8: Selected water quality data for Whangamarino River at Island Block Road (LAWA).

Parameter	5-year median	Trend (noted by LAWA)	Plan Change 1 Target	
			Short Term	Long Term (80y)
E.coli (100 n/100ml)	110	Likely Improving	170	130
Clarity (m)	0.16	Very likely degrading	0.3	1
Total nitrogen (mg/L)	2.149	Very likely degrading	0.075	0.075
Total phosphorus (mg/L)	0.15	Likely degrading	0.006	0.006

[8] Land Air Water Aotearoa (n.d) Whangamarino River at Island Block Road. https://www.lawa.org.nz/explore-data/waikato-region/river-quality/waikato-river/whangamarino-river-at-island-block-rd. Accessed 6 November 2024.

The trends for the river indicate overall degradation in water quality. Against Plan Change 1 values, the river does not meet the short term or long term values.

5 Discharge Characteristics

5.1 Existing Flow

Table 9 below summarises the average annual outflow for the WWTP. The consented limit is 1100m^3 as an annual average; with no exceedances observed between 2019-2023. 2024 has not been included data for the full year has not been received.

Table 9: Average annual outflow for the WWTP.

Year	Average Annual Outflow (m^3)
2019	1005
2020	872
2021	902
2022	854
2023	861

5.2 Existing Discharge Quality

Watercare has provided Beca with discharge quality data from June 2017 to August 2024. The figures below show the discharge quality for nutrients, TSS, $cBOD_5$, and *E.coli*, total nitrogen load and total phosphorus load over that timeframe compared to discharge limits specified under condition 8 of the resource consent, where one year is defined as 1 July to 30 June (data post 30 June 2024 has not been included in the figures). For the purpose of condition 8, the consent states that to determine compliance with the median limits for contaminants (excluding *E.coli*), no more than six samples in any 12 consecutive monthly samples over the period 1 July to 30 June each year shall exceed the specified limit. For the *E. Coli* median limit, no more than 13 samples in any 26 consecutive fortnightly samples shall exceed the specified limit (i.e., no more than half the samples in a monitoring year).

The results below are compared to the relevant discharge limit, with exceedances reflecting instances determined by the compliance methodology outlined in condition 8 of the consent.

Both nitrogen and phosphorus loads have regularly exceeded consent limits over time (Figure 5). Phosphorus loads in 2023-2024 period were below the consent limit.

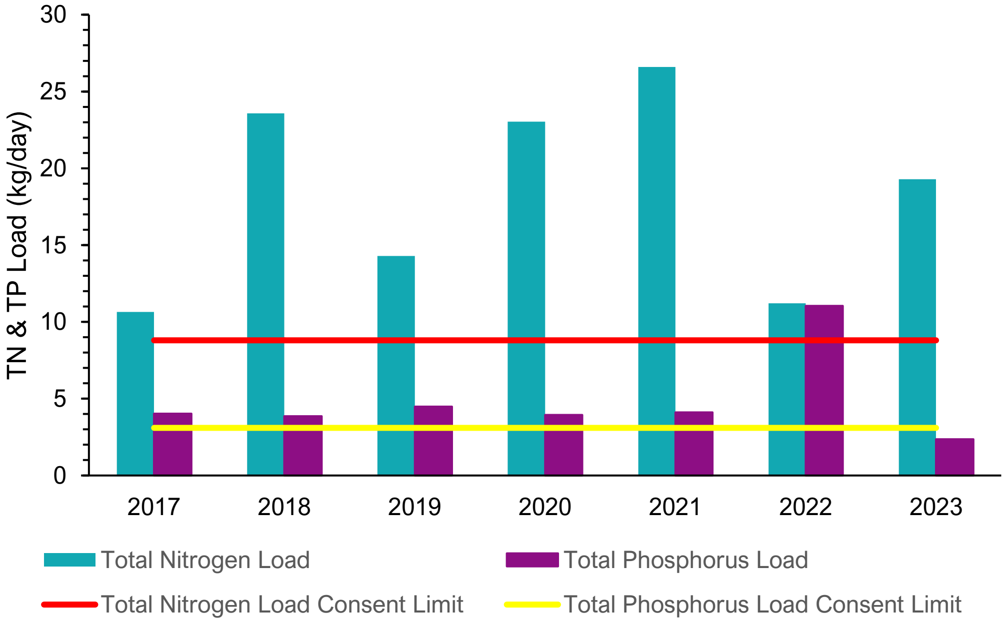

Figure 5: Annual median total nitrogen and total phosphorus loads

TKN also regularly exceeded its consent limit over the past six years of monitoring (Figure 6).

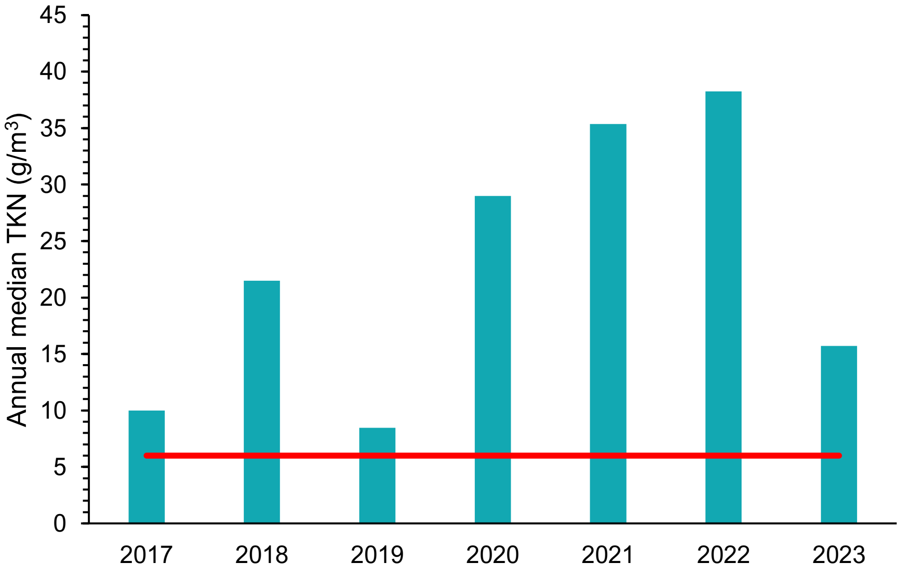

Figure 6: Annual median total kjedahl nitrogen. Red line is the consent limit

Total nitrogen and total phosphorus trends follow a very similar trend to those shown in Figure 5, although phosphorus is less likely to exceed its consent limit (Figure 7).

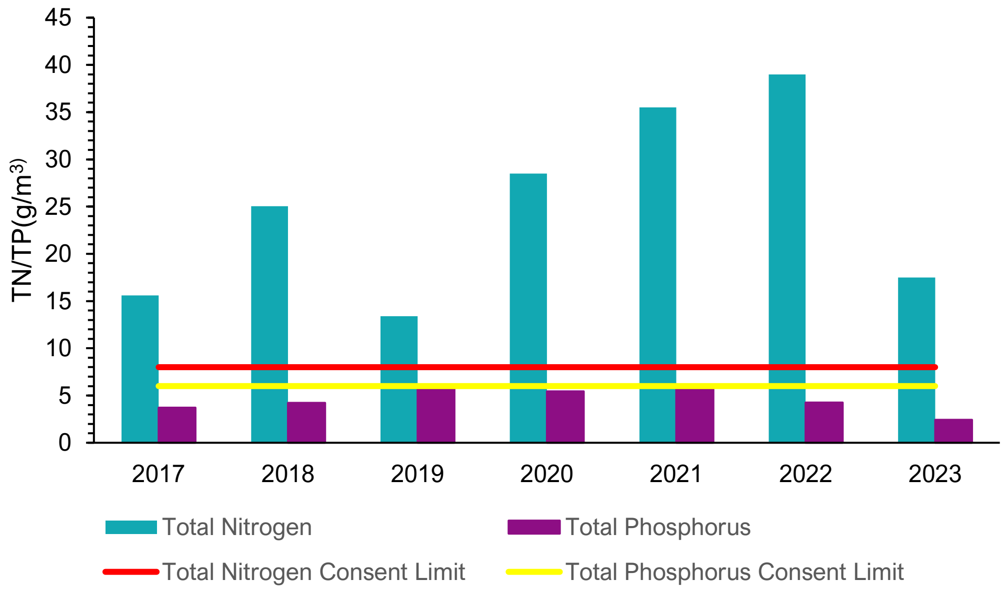

Figure 7: Annual median total nitrogen and total phosphorus concentrations

$cBOD_5$ concentrations in the WWTP discharge have exceeded the consent limit three out of the past six years (Figure 8). For the 2023 period the concentration has been much lower than previous years, due to the MABR upgrades installed.

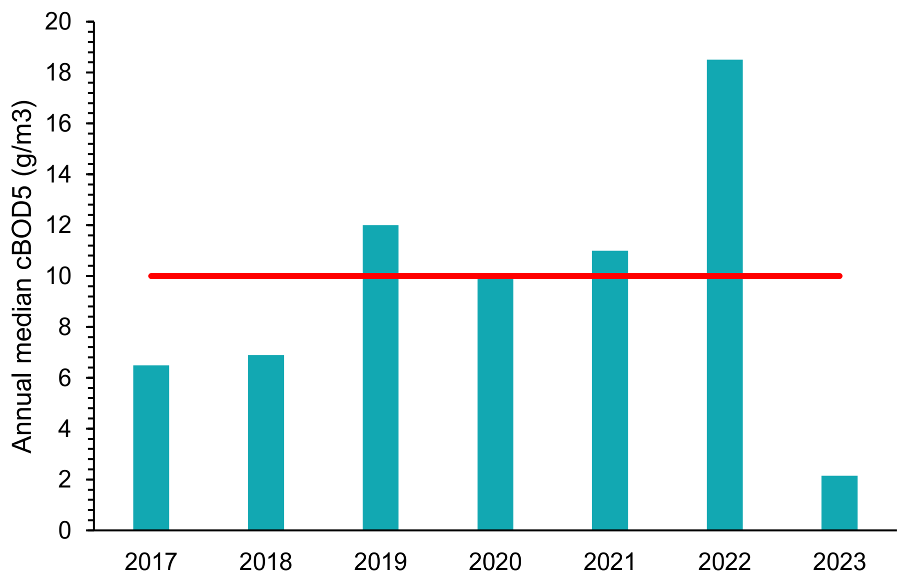

Figure 8: Annual median 5 day carbonaceous biochemical oxygen demand. Red line is the consent limit

The *E.coli* median limit (1500 MPN/100mL in 12m period) has not been exceeded in the past three years (Figure 9). More recent results show the improvement in the operation of the UV system and the MABR has been operational since December 2023.

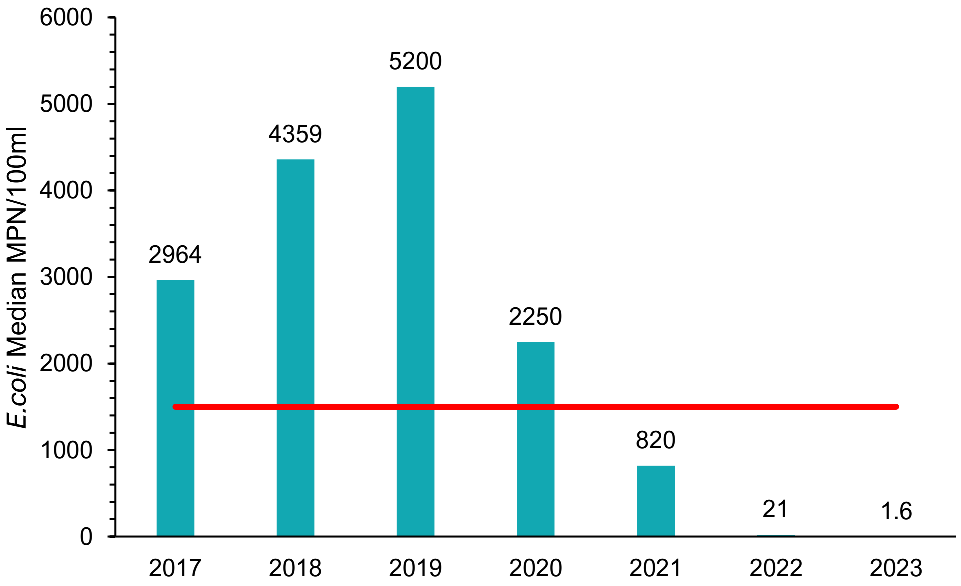

Figure 9: Annual *E.coli* median results. Red line is the consent limit.

TSS has been non-compliant in the WWTP discharge throughout 2017-2022 (Figure 10). The 2023 period is well below the limit, likely due to the installed MABR upgrades commissioned in December 2023.

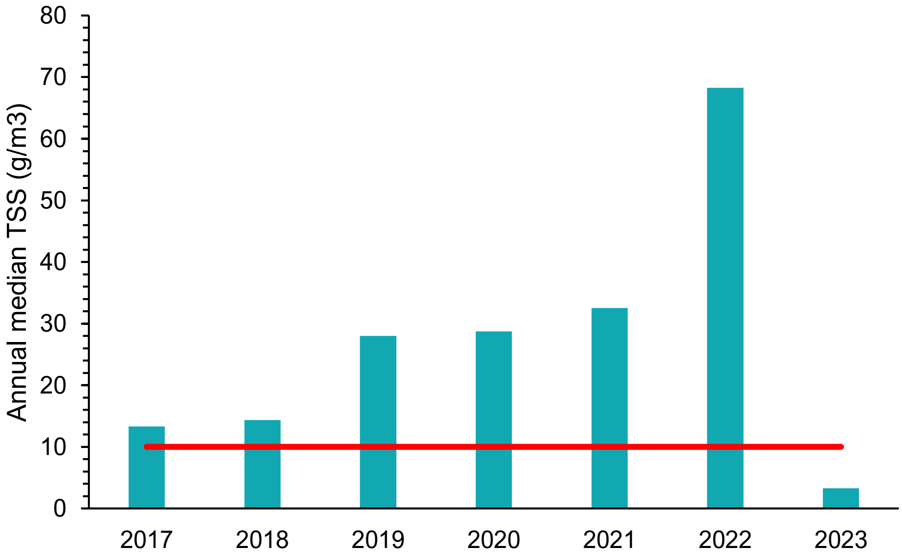

Figure 10: Median total suspended solids. Red line is the consent limit.

5.3 Predicted Discharge Characteristics

Watercare provided Beca with the expected performance values for the MABR upgrades. These are included in Table 10 below. Median values from monitoring pre and post upgrade is also included. The upgrades have made a significant improvement in treated wastewater quality parameters and the post upgrade values are well within the performance expectations of the upgrades.

Table 10: MABR Treatment Specifications and median values based on monitoring data to date

Parameter	Median pre MABR Upgrades (July 2017-Dec 2023)	Median Upgrade Performance Value (specified by Watercare)	Median post MABR Upgrades (Jan 2024-Aug 2024)
$cBOD_5$ (mg/L)	8.6	<10	0.7
TSS (mg/L)	23	<5	2.6
E.coli (cfu/100mL)	2000	<10	1.6
TN (mg/L)	28.2	< 8	3.6
TP (mg/L)	4.7	<5.6	2.6

6 Water Quality Assessment

6.1 Discharge Channel and Lake Waikare

Water quality in the channel (based on the one-off sampling) has been assessed as “unsatisfactory” for a number of parameters based on WRC river water quality guidelines (ecological and contact recreation) and was above the ANZG (2018) water quality trigger values for all parameters aside from pH.

However, to assess the effects of the discharge on the water quality of the channel and wider Lake a comparative assessment has been made between the MABR treated wastewater quality, the results of the channel sampling and the longer term WRC Lake Waikare water quality data. This summary is shown in Table 11.

Table 11: Comparison of MABR, channel and Lake Waikare water quality

Parameters	MABR discharge quality	Channel water quality (from one-off sampling)			Lake Waikare water quality (from WRC records)[9]
		Site S1	Site S2	Site S3	
$cBOD_5$ (mg/L)	0.7	N/A[10]	N/A	N/A	N/A
TSS (mg/L)	2.6	4	38	71	N/A
E.coli (cfu/100mL)	1.6	548	866	1203	194 (95%ile)
TN (mg/L)	3.6	2.7	1.7	2.7	4.68
TP (mg/L)	2.6	0.26	0.21	0.31	0.19

- $cBOD_5$ is very low in the discharge and is highly unlikely to contribute to the wider dissolved oxygen depletion observed in the discharge channel and Lake, in fact the dissolved oxygen in the discharge is likely to be higher than the Lake.
- TSS concentrations in the discharge are much lower than the discharge channel, again showing the discharge is of a higher quality than the Lake.
- The TN concentration of the discharge is of a higher quality than the Lake, and on the day of sampling showed lower concentrations in the discharge channel.
- The TP concentration is higher than the Lake, however on the day of sampling the concentrations in the discharge channel were similar to the long-term Lake water quality, showing no obvious effects on TP concentrations in the discharge channel.
- For E. coli, the discharge is of a much higher quality than the Lake.

Overall it is considered that the MABR discharge quality is of a higher quality than the Lake Waikare water quality, with the only exception being for phosphorus, which shows no observable effects in the discharge channel, compared to the background Lake water quality.

6.2 Nutrient Contributions from the WWTP

Lake Waikare is a large lake with a significant catchment and water quality is monitored at a single point in the lake by WRC as described in Section 3.3.

---

[9] Average value from Table 6.

[10] N/A indicates records not available.

To understand likely mass load contributions from the WWTP relative to the catchment, the predicted discharge characteristics (flow and quality) have been used to calculate nutrient loads to calculate potential percent contributions based on modelling completed by Cox & Cooke (2014)[11]. The paper investigated potential flushing strategies to the Waikato River for the purposes of pushing large amounts of nutrients and phytoplankton out of the Lake. The paper also included modelling of catchment nutrient load contributions from lake inlets; total nutrient loads from all land uses and discharges were 578 tonnes/yr (t/yr) and 96 t/yr for nitrogen and phosphorus respectively (converted to kg/day for Tables 8 and 9).

The percent contribution loads were calculated by taking the median TN and TP concentrations (g/m^3) and multiplying it by average daily flow (ADF). Estimations based on the Mid Waikato Strategy 2050 population projections were also included in the calculations, using recommended consent limits given in Table 3.

Tables 12 and 13 below summarise the percent contribution loads for the WWTP prior to the MABR upgrade. Table 12 uses pre-upgrade flows from 2020-2023 due to the short data collection period available for post-upgrade operation (approximately 1 year) for comparison.

Table 12: Percent contribution of nutrients to Lake Waikare based on pre upgrade flows

Parameter	Catchment excluding WWTP kg/day Cox & Cooke (2014)	WWTP ADF	
		Pre Upgrade (2020-2023) average load kg/day	Pre upgrade percent contribution
Total nitrogen load	1580	28.7	1.8%
Total phosphorus load	260	4.6	1.76%

Table 13: Percent contribution of nutrients to Lake Waikare based on 2050 flows

Parameter	Catchment excluding WWTP kg/day Cox & Cooke (2014)	Mid Waikato Strategy Predicted ADF (2050)	
		Median kg/day	Percent Contribution
Total nitrogen load	1580	20	1.2%
Total phosphorus load	260	4.5	1.73%

Tables 11 and 12 show a reduction in TN mass loads to Lake from 1.8% pre-MABR upgrade to 1.2% at 2050. The reduction for TP mass loads is 1.76% to 1.73%.

Overall, the improvements to the WWTP discharge contribute to the overall betterment of Lake Waikare, as such any further eutrophication of the lake is highly unlikely to be caused by the WWTP discharge, and load reduction has been achieved through the WWTP upgrade, showing that even with significant growth in connected population the ultimate nutrient loads discharged to the Lake will remain below pre-MABR upgrade levels.

[11] Cox & Cooke (2014) Lake Waikare Water Quality Modelling: Using a New Model to Investigate Flushing Strategies. *Proceedings of the Water NZ Annual Conference (2014)*

7 Summary

The Te Kauwhata WWTP has historically not complied with its discharge consent, which, as well as affecting water quality values, has also affected community and cultural perception of the discharge. This has been exacerbated by the hypertrophic state of the receiving environment, Lake Waikare, although previous work by Beca has shown that its state has primarily been caused by the effects of the Lower Waikato flood control scheme, catchment land uses and the loss of macrophyte beds.

Overall, the receiving environment has very poor water quality as evidenced by sampling and long-term monitoring.

To comply with its consent and prepare for future increased flows in line with population projections, Watercare has examined the best options for the plant discharge and has also installed a significant upgrade (MABR/MBR) that have brought all water quality measures in line with the existing consent conditions.

These upgrades led to a significant improvement in discharge quality, bringing all monitoring results within consent limits since the upgrades were installed in late 2023.

Sampling undertaken for this investigation has shown that the MABR/MBR discharge quality is of a higher quality than the Lake Waikare, with the only exception being for phosphorus, which shows no observable effects in the discharge channel, compared to the background Lake water quality.

A long-term assessment has also been undertaken and shows that the WWTP can provide for population growth through to 2050, with proposed treatment limits ensuring that the ultimate 2050 nitrogen and phosphorus loads to the Lake remain below pre-MABR upgrade levels.

Overall, the improvements to the WWTP discharge contribute to the overall betterment of Lake Waikare consistent with Plan Change 1 (PC1) of the Waikato Regional Plan and Te Ture Whaimana o te Waikato The Vision and Strategy for the Waikato River.