Te Hoiere Project | HAERE, KAKEA TE ARA POKA HOU

Te Hoiere Water Quality Mitigation Effectiveness Monitoring Report

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Figures & tables

Figure 1: Locations of the Mitigation Effectiveness Monitoring Sites within the Te Hoiere Project area. 4

Table 1: Statistical significance categories used in this report. 4

Figure 2: Nitrate Nitrogen concentrations at the monitoring sites during the 2020/21 baseline study and the 2023/25 mitigation effectiveness monitoring. Sites with statistically significant changes are framed, with the colour of the frame being indicative of the change. 5

Figure 3: Total Ammoniacal Nitrogen concentrations at the monitoring sites during the 2020/21 baseline study and the 2023/25 mitigation effectiveness monitoring. Sites with statistically significant changes are framed, with the frame colour indicative of the uncertainty for the change. 6

Figure 4: Dissolved Reactive Phosphorus concentrations at the monitoring sites during the 2020/21 baseline study and the 2023/25 mitigation effectiveness monitoring. Sites with statistically significant changes are framed, with the colour of the frame indicating the uncertainty. 7

Figure 5: E. coli concentrations at the monitoring sites during the 2020/21 baseline study and the 2023/25 mitigation effectiveness monitoring. Sites with statistically significant changes are framed, with the colour of the frame indicating the uncertainty. 8

Figure 6: Turbidity at the monitoring sites during the 2020/21 baseline study and the 2023/25 mitigation effectiveness monitoring. Sites with statistically significant changes are framed, with the colour of the frame indicating the uncertainty. 9

Figure 7: The Linkwater catchment group has been one of the most engaged and proactive group of farmers in the Te Hoiere Project area. The Figure shows a new article, the group during a catchment group meeting (top right) and the release of dung beetles (bottom right). 10

Figure 8: Fencing and planning of large sections of the streams in the Rai catchment have resulted in measurable improvements in water quality at site RVS-1. 10

Table 2 : P-values for Wilcoxon Test. Cell are coloured based on associated uncertainty category in Table 1 of the report 12

Executive Summary

This report outlines the progress and impact of collaborative efforts to improve water quality in the Te Hoiere region. Te Hoiere Project is a partnership of the community, iwi, local and central government, NGO's and industry bodies, which aims to tackle challenges such as improving river health through innovation, research, technical support and on the ground restoration activities.

Key initiatives include over 88 km of fencing and the planting of more than 211,000 native plants. These actions, combined with educational outreach and landowner engagement, aim to improve water quality. To assess whether these actions have been successful, the Mitigation Effectiveness Monitoring Programme was initiated. Monitoring for this programme began in November 2023 and includes monthly sampling of key water quality parameters across selected sites. Statistical analysis comparing current data to the 2020/21 baseline reveals significant improvements in several areas:

- Reductions in Nitrate and Ammoniacal Nitrogen concentrations, particularly at sites with extensive fencing and planting.
- Decreased E. coli levels at multiple sites, attributed to improved land management practices.
- Lower turbidity and phosphorus levels, indicating reduced erosion and runoff.

The most notable improvements were observed at site RVS-1 near Rai Valley township, where mitigation efforts have led to measurable water quality enhancements. Conversely, sites with limited or no mitigation actions showed minimal change, underscoring the importance of continued investment.

Recommendations include:

- Prioritizing monitoring at sites with active or planned mitigation measures.
- Discontinuing monitoring at sites with no foreseeable mitigation actions.
- Conducting annual reviews to ensure the program remains effective and aligned with project goals.

Overall, the report demonstrates that targeted mitigation actions can lead to tangible improvements in stream health, reinforcing the value of continued community engagement and strategic investment.

Introduction

Te Hoiere project is a collaboration between community, iwi and different agencies with the aim to improve the ecological health of the Te Hoiere area while supporting cultural, social and economic wellbeing. One focus is enhancement of stream and river health.

Intensive water quality monitoring at the beginning of the project showed where water quality improvements were most needed [3]. Since then, the project supported over 88 km of new fencing and planting of more than 211,000 native plants. Workshops and information distributed as part of the programme are raising awareness of why stream health is important, explain processes effecting ecological, soil and river health, and provide options for possible improvement in management practices.

Following the substantial work carried out, it is important to monitor the effectiveness of these measures in achieving the goal of improving water quality in streams and rivers. This allows refining of mitigation strategies and builds public trust in the ability of the project to achieve the intended outcomes. Showcasing improvements also has the potential to bring landowners on board that have been reluctant in the past.

While some mitigation measures such as fencing are likely to result in relatively quick improvements, plantings need time to establish to perform their function. Monitoring the effectiveness of different mitigation measures therefore requires ongoing effort, with results informing future steps where needed.

There are seven river State of the Environment (SoE) monitoring sites within the Te Hoiere project area. These sites are monitored monthly for physical and chemical parameters and have been monitored for over 10 years. However, these sites are located on comparatively large rivers and streams (stream order 3 and higher) to provide river health information on a regional scale. Modelling done as part of the National Science Challenge has shown that the effectiveness of mitigation measures is more likely to be observable within shorter timeframes in smaller streams [1].

Methodology

Due to uncertainties in long-term budget availability, mitigation monitoring is being carried out at a limited number of sites with monitoring of the most essential parameters only. This ensures that Marlborough District Council can temporarily fund the continuation of the monitoring should no further funding be found for Te Hoiere Project.

Monitoring sites were chosen based on results of the 2020/21 baseline monitoring and the location of proposed and completed mitigation actions. One reference site with minimal impacts from human activities was also included to allow correction for natural variation when assessing changes in water quality.

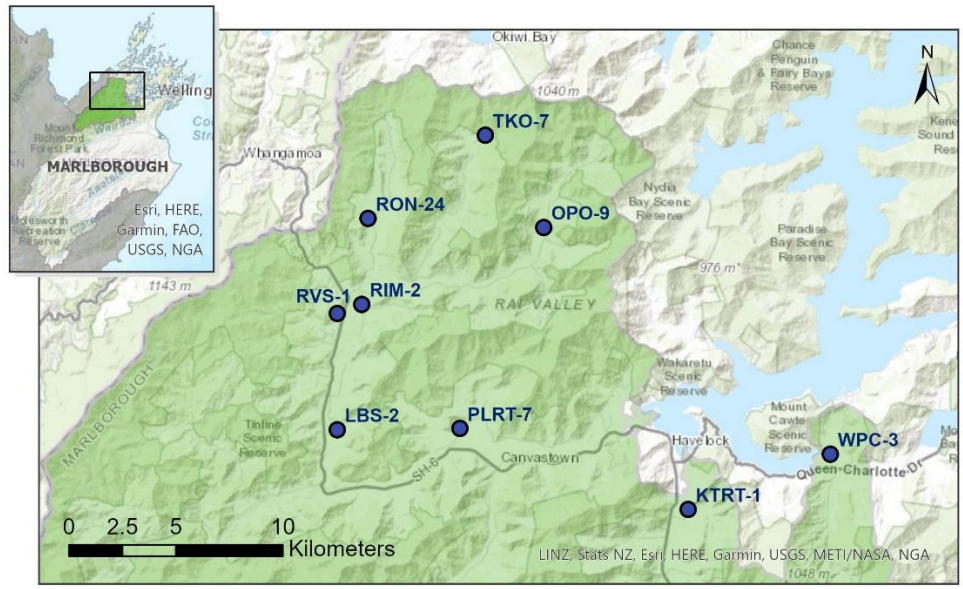


Figure 1: Locations of the Mitigation Effectiveness Monitoring Sites within the Te Hoiere Project area.

The sites are visited monthly during all weather conditions with samples analysed by an accredited laboratory (Hill Laboratories) for the following parameters:

- pH
- Total Ammoniacal Nitrogen
- Nitrite/Nitrate Nitrogen
- Nitrate Nitrogen
- Dissolved Reactive Phosphorus
- *E. coli*
- Turbidity

Monitoring began in November 2023 and is ongoing. The analysis in this report uses the data from the beginning of the monitoring until March 2025. For sites that were also monitored during the 2020/21 baseline study, results are compared using the Wilcoxon "signed-ranked" Test [4] to determine if there have been statistically significant changes for the monitored parameters since the baseline monitoring.

Although generally p-values of less than 0.05 are considered to indicate statistical significance[1], changes with slighter higher p-values are also shown as potential changes with greater uncertainty (see *Table 1*). This modified approach based on Choquette et al. (2019) [2] aligns with recent guidance on interpretation of trend analysis [5].

Table 1: Statistical significance categories used in this report.

p-value	Meaning
< 0.05	Highly Likely change in water quality
0.05 – 0.10	Very Likely change in water quality
0.10 – 0.15	Likely change in water quality

[1] Rejection of the null hypothesis that there is no change

Results

The following sections describe the significance of each measured parameter for river health and compare recent monitoring results (2023/25) with those from the 2020/21 baseline study where available. Site TKO-7 is a reference site with minimal human influences, which allows measurements of others site to be compared to natural conditions. It also provides information on natural variability of measurements.

Nitrate Nitrogen

Nitrate Nitrogen is the most common form of dissolved nitrogen in Marlborough's rivers. Dissolved Nitrogen fuels algae growth, but very high concentrations can be directly toxic to aquatic organisms.

Naturally, dissolved Nitrate Nitrogen concentrations are very low. In the Te Hoiere catchment, elevated levels typically result from nitrogen leaching due to fertilizer use and cattle urine. During rainfall or irrigation, the highly soluble Nitrate is transported into the soil where it can be absorbed by plant roots. However, if Nitrate is carried below the depth of plant roots it is transported via sub-surface and groundwater flows into nearby rivers and streams. Occasional, very high concentrations of Nitrate Nitrogen, however, are more likely caused by direct inputs, such as when livestock enters a stream or when overland flow washes animal droppings into the waterway.

The Marlborough Environment Plan (MEP) sets a target of median Nitrate Nitrogen concentrations below 1.0 g/m^3 and annual maxima not exceeding 1.5 g/m^3.

Figure 2 shows the comparatively low Nitrate Nitrogen concentrations at the reference site, TKO-7. For all sites, including the reference site, median concentrations were lower during recent monitoring compared to the baseline study. During the 2020/21 baseline study three sites had median concentration above the MEP target level. During recent monitoring only site WPC-3 in Linkwater remained above the MEP target.

Nitrate Nitrogen leaching varies naturally, and rainfall is one of the main factors causing this variability. Prolonged rainfall has a potential to increase the amount of nitrogen leached into groundwater.

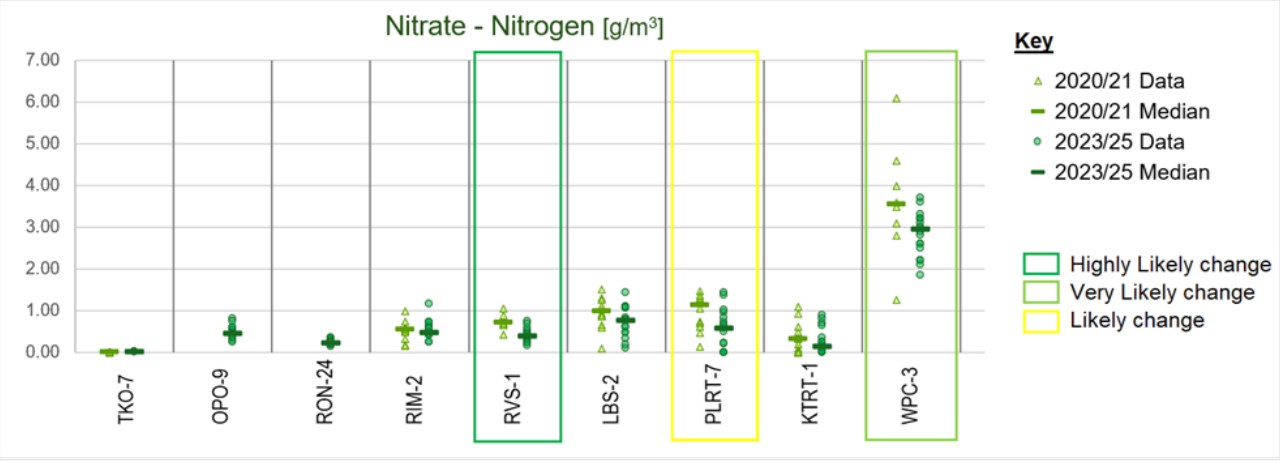


Figure 2: Nitrate Nitrogen concentrations at the monitoring sites during the 2020/21 baseline study and the 2023/25 mitigation effectiveness monitoring. Sites with statistically significant changes are framed, with the colour of the frame being indicative of the change.

The analysis of the data shows statistically significant changes for three sites only with the greatest certainty for a reduction at site RVS-1. This site is located near Rai Valley township and large sections of the stream network upstream of the monitoring site have been fenced and planted. This has resulted in less livestock access to streams and hence a reduction in direct inputs of nitrogen. Planting of the fenced stream banks also helps to reduce nitrogen as the vegetation absorbs it via the root system.

Site WPC-3 also shows statistically significant reduction in Nitrate concentrations. During the 2020/21 baseline monitoring, Nitrate-Nitrogen concentrations had a large range in values, which is indicative of regular direct

inputs, while the recent monitoring shows a much more reduced range. There has been no fencing or planting of waterways upstream of this site. however, the farm has changed ownership, with the current owners being highly involved in the project. Although, land use has not changed, the reduction in Nitrate concentrations is likely is caused by better land management practices. This includes the removal of organic material that had been stored near waterways, the release of dung beetles and discontinuation of a problematic underpass.

Site PLRT-7 also showed a reduction in Nitrate Nitrogen concentrations. The land has been under new management and although not funded through the project, all waterways have since been fenced.

Ammoniacal Nitrogen

Ammoniacal Nitrogen is another form of dissolved nitrogen. Elevated concentrations are typically caused by high inputs of organic material or prolonged periods of low dissolved oxygen. However, the streams monitored in this programme are less prone to low oxygen due to natural aeration from riffle sections. In some areas, subsurface flows with low oxygen may contribute, but the primary source of elevated ammoniacal nitrogen is organic matter such as animal waste or decaying vegetation.

High levels of ammoniacal nitrogen are toxic to aquatic life, with toxicity influenced by pH and temperature. While toxicity assessments usually adjust for these factors, water temperature was not monitored, so direct comparisons to guidelines were limited. Nevertheless, high Ammoniacal Nitrogen concentrations are generally likely to have negative effects on stream ecology.

The MEP sets targets of median concentrations below 0.03 g/m^3 and requires annual maxima to not exceed 0.05 g/m^3.

Figure 3 shows the Ammoniacal Nitrogen concentrations at monitoring sites during the 2020/21 baseline study and the 2023/25 mitigation effectiveness monitoring. Ammoniacal Nitrogen levels were consistently below the detection limit of 0.005 g/m^3 for the reference site TKO-7as well as site OPO-9 on the Opouri River.

Many of the other sites have regularly elevated Ammoniacal Nitrogen concentrations. Median concentrations showed reductions for many sites, but changes were statistically significant for only two, WPC-3 and RVS-1. Site WPC-3 in Linkwater generally had the highest concentrations but also showed the greatest reduction. As described in the previous section, these changes are likely a result of improved management practices. Still, further improvements are needed to ensure the targets in the MEP are met consistently.

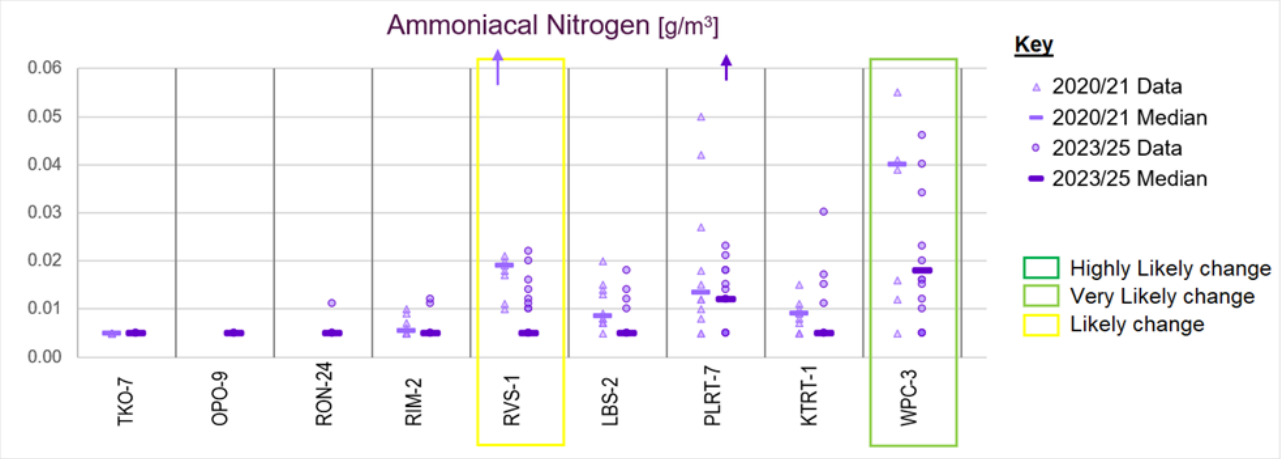


Figure 3: Total Ammoniacal Nitrogen concentrations at the monitoring sites during the 2020/21 baseline study and the 2023/25 mitigation effectiveness monitoring. Sites with statistically significant changes are framed, with the frame colour indicative of the uncertainty for the change.

Statistically significant reductions in Ammoniacal Nitrogen concentration were also observed for site RVS-1 near Rai Valley township. The lower concentrations are a result of large sections of fencing and planting, reducing livestock access and creating a buffer for rainfall run-off. More than half of the recent measurements were below the detection limit, compared to consistently elevated levels during baseline monitoring.

Dissolved Reactive Phosphorus (DRP)

Dissolved Reactive Phosphorus (DRP) is the form of phosphorus readily absorbed by plants. High DRP concentrations can therefore cause excessive algae growth, which results in degradation of habitat for aquatic animals and reduced aesthetic values for swimmers and other recreational users.

Phosphorus usually binds well to soil, which means that erosion is a major source of phosphorus in waterways. Occasionally very high DRP concentrations observed at most sites are related to rainfall events and associated run-off from surrounding land areas, but other sources such as direct inputs from fertilizer and animal waste also cause elevated concentrations.

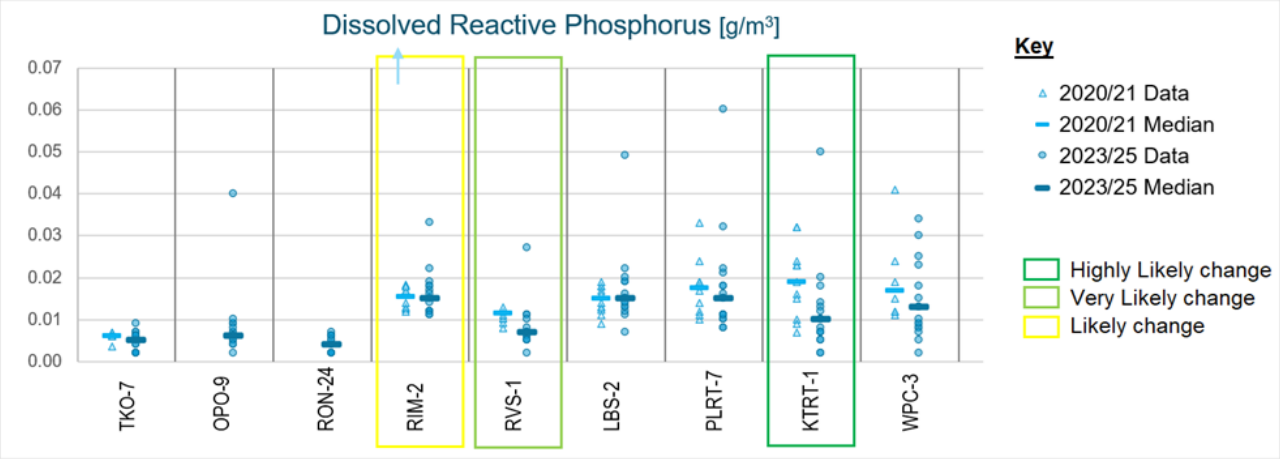


Figure 4: Dissolved Reactive Phosphorus concentrations at the monitoring sites during the 2020/21 baseline study and the 2023/25 mitigation effectiveness monitoring. Sites with statistically significant changes are framed, with the colour of the frame indicating the uncertainty.

DRP concentrations at the reference site, TKO-7, are slightly higher than in the Ronga River (RON-24), which is a result of differences in the underlying geology. Three sites have DRP concentrations consistently above those potential background levels, RIM-2, LBS-2 and PLRT-7. All three sites have their headwater in the same mountain range which includes Mt Rimu and Mt Rutland. During the 2020/21 baseline monitoring additional sites in the upper reaches showed similarly elevated DRP concentrations. This indicates that DRP levels in this area are naturally higher than in the Tunakino and Ronga catchments. Although geological phosphorus sources can lead to overall elevated concentrations, the variability of measurement values is naturally quite limited (as can be seen for TKO-7). Therefore, large variability in phosphorus concentrations indicates additional substantial human induced inputs, such as from livestock access. This is particularly the case for site PRT-7 in the lower Te Hoiere/Pelorus catchment.

Variability in DRP concentrations is also comparatively large for sites KTRT-1 and WPC-3. Site KTRT-1 in the Kaituna catchment shows a statistically significant reduction in DRP concentrations, however, it is unclear what caused this, as mitigation measures have been restricted to downstream areas. Landowners at this particular site have been involved with the project and it is possible that changes in management practices led to reduced loss of phosphorus to the waterways on the property.

Statistical analysis also showed a significant reduction in DRP concentrations for site RVS-1 near Rai Valley township. Extensive fencing and riparian planting of upstream stream sections have resulted in reduced stream bank erosion. The comparatively narrow range in values at this site, suggests that ongoing erosion rather than occasional direct inputs from stock access was a main contributor to elevated DRP concentrations.

DRP concentrations at site RIM-2 showed a minor but statistically notable reduction, though improvements remain limited.

E. coli

E. coli is an indicator bacterium for faecal contamination from animal droppings and human wastewater. In the context of the Te Hoiere Project, elevated E. coli concentrations are almost exclusively linked to animal waste. Naturally, E. coli concentrations can spike during rainfall events due to surface runoff, but levels are typically low during dry periods. This can be seen for sites TKO-7 and OPO-9 (*Figure 5*).

At other sites, E. coli concentrations are generally elevated, exceeding the national limit for median concentrations of 130 n/100mL[2]. Here the most likely source are direct inputs from livestock access to streams, swales and small springs. Concentrations are particularly high at sites RVS-1, KTRT-1 and WPC-3. Of these sites KTRT-1, in the Kaituna catchment and WPC-3 in Linkwater show large reductions which are statistically significant. These reductions are likely due to improved land management rather than physical mitigation measures, as upstream fencing and planting were limited.

Site PLRT-7 in the lower Te Hoiere/Pelorus also shows a statically significant reduction which is a result of fencing all waterways on the property.

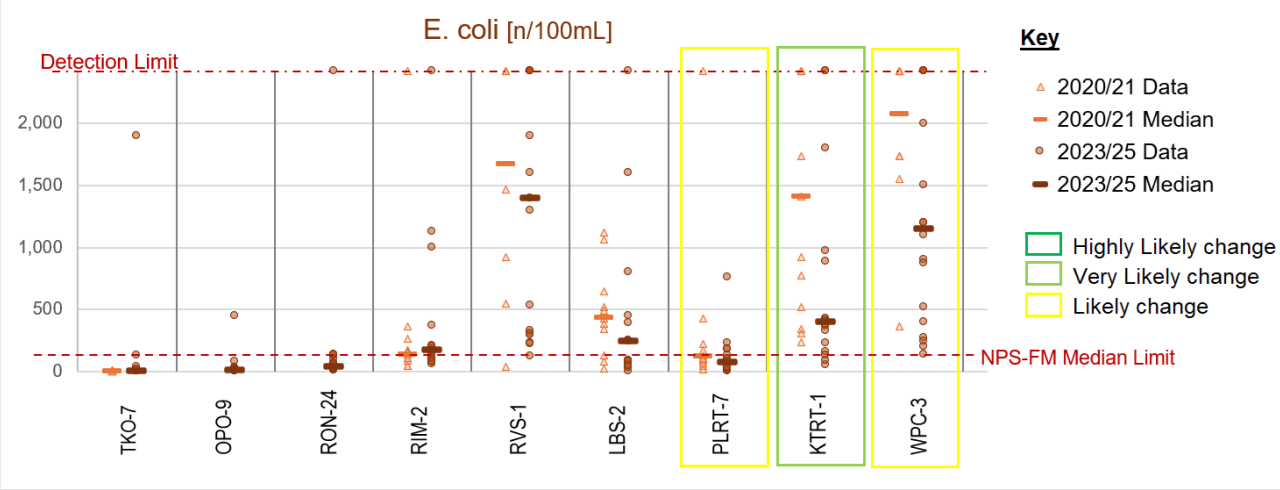


Figure 5: E. coli concentrations at the monitoring sites during the 2020/21 baseline study and the 2023/25 mitigation effectiveness monitoring. Sites with statistically significant changes are framed, with the colour of the frame indicating the uncertainty.

Despite these improvements, E. coli levels at several sites remain above acceptable thresholds, indicating the need for further action to reduce faecal contamination.

Turbidity

Turbidity is a surrogate measure for sediment carried within stream and river water. Naturally, turbidity is low and occasional higher values are associated with erosion during higher flows only. This can be seen for sites TKO-7 and OPO-9. At all other sites, turbidity values are generally elevated, indicating ongoing erosion which can be caused by damage to stream banks by livestock.

Analysis of the data showed a small, but statistically significant reduction in turbidity at the TKO-7 reference site. The reason is likely linked to lower flows during the more recent 2023/25 sampling. This natural variation means that linking reduced turbidity at other sites to mitigation actions needs to be done with caution.

[2] There are four different limits for the E. coli attribute in the in the National Policy Statement for Freshwater Management 2020, the median limit is one of them.

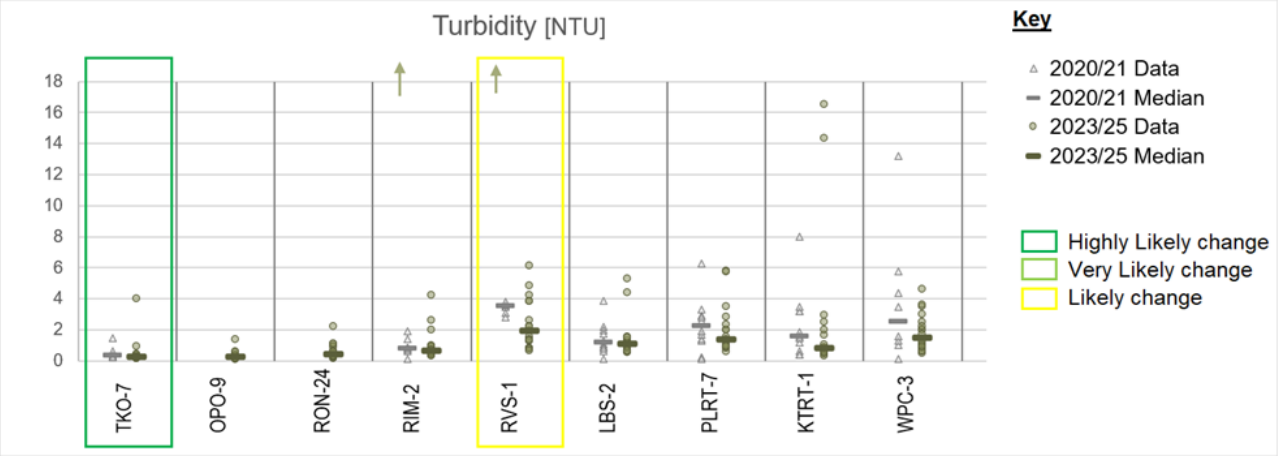


Figure 6: Turbidity at the monitoring sites during the 2020/21 baseline study and the 2023/25 mitigation effectiveness monitoring. Sites with statistically significant changes are framed, with the colour of the frame indicating the uncertainty.

All sites showed lower median turbidity values when compared to the 2020/21 baseline monitoring, but only other site, RVS-1, had reductions that were statistically significant. The improvement at this site is likely linked to extensive upstream fencing and riparian planting, which have stabilised stream banks and reduced sediment input.

Macroinvertebrate Community Index (MCI)

Macroinvertebrates are small aquatic animals, such as insects and snails. The presence and diversity of the different species reflects long-term water quality and habitat conditions. The sensitivity of species to contamination and their abundance are combined to calculate a Macroinvertebrate Score, the MCI. Higher MCI values indicate better stream health.

Macroinvertebrates are sampled annually during summer and have only recently been added to the programme. This means assessments of changes are currently not possible. However, the initial results offer valuable insights into the current state of stream ecosystems. The reference site TKO-7 recorded the highest MCI score, consistent with its location in native bush and minimal human impact. In contrast, sites WPC-3 and PLRT-7 had the lowest MCI scores, aligning with the poorer water quality results for the other parameters monitored. This shows that that degraded water quality is affecting aquatic biodiversity at these sites.

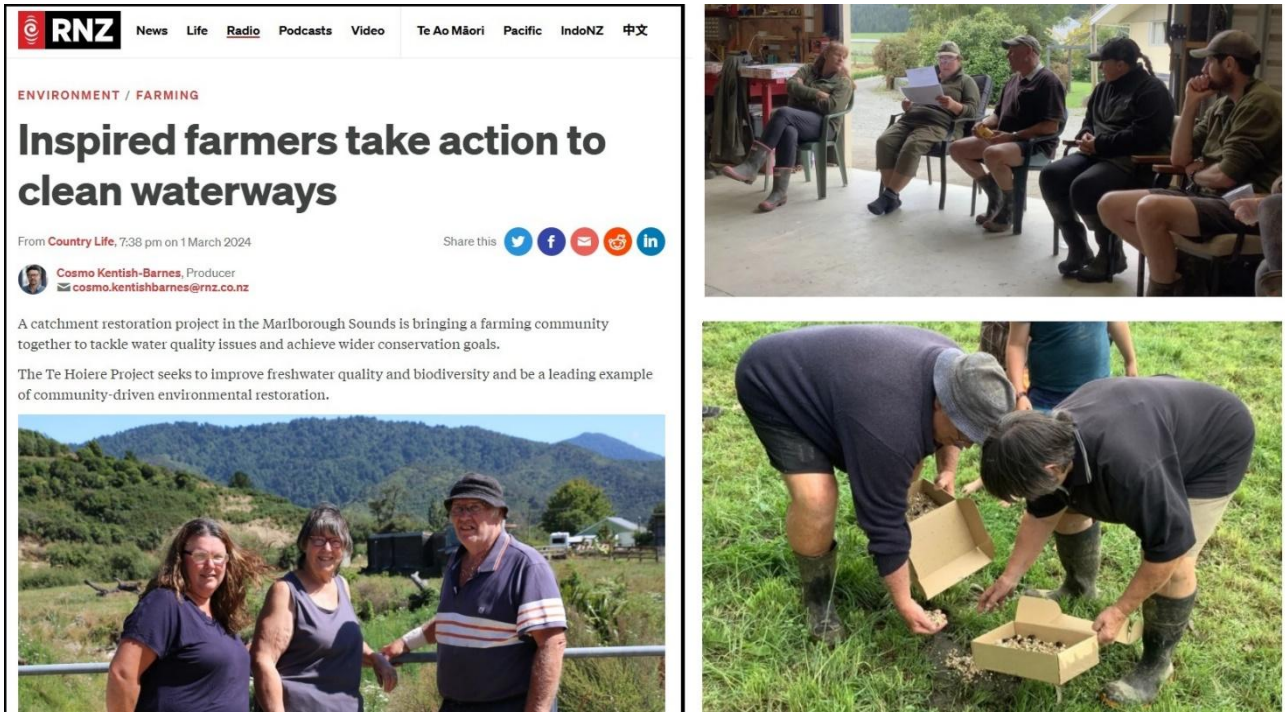
Discussion

The monitoring results show the effects of varying mitigation effort. No significant changes in water quality were observed for sites RIM-2 and LBS-2 in the Rai catchment. This is to be expected as there have been no mitigation measures in the stream reaches upstream of these sites. Of these two sites, LBS-2 in the lower Rai catchment has the poorer water quality and should therefore be a focus for landowner engagement.

Site PLRT-7 in the lower Te Hoiere/Pelorus catchment also lacked recorded mitigation actions, but new farm management has resulted in fencing of all waterways on the property. This has resulted in statically significant reductions in Nitrate Nitrogen and E. coli. However, further work is needed to address erosion and phosphorus inputs. This site also recorded some of the highest Ammoniacal Nitrogen concentrations, likely due to contamination from organic material such as stored waste or animal droppings.

Dairy cattle are the predominant livestock within the Te Hoiere Project areas, but within the Kaituna catchment and associated site KTRT-1 pastures are grazed mainly by beef and sheep. Although fencing and planting have been limited to downstream reaches, reductions in E. coli and phosphorus concentrations were observed. These improvements may be linked to better land management, but additional efforts are needed to further reduce contamination. The steep terrain and small stream size make fencing challenging, so alternative mitigation strategies may be required.

Site WPC-3 in Linkwater consistently had the poorest water quality across both monitoring periods. Despite the absence of upstream fencing or planting, significant improvements were recorded in several parameters, including Ammoniacal Nitrogen and E. coli. These changes are attributed to proactive land management by new owners, including the removal of organic waste near waterways and the release of dung beetles (*Figure 7*). Continued support and investment in mitigation measures in this part of the project area is recommended to build on these early successes.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ENVIRONMENT / FARMING

Inspired farmers take action to clean waterways

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A catchment restoration project in the Marlborough Sounds is bringing a farming community together to tackle water quality issues and achieve wider conservation goals.

The Te Hoiere Project seeks to improve freshwater quality and biodiversity and be a leading example of community-driven environmental restoration.

Figure 7: The Linkwater catchment group has been one of the most engaged and proactive group of farmers in the Te Hoiere Project area. The Figure shows a new article, the group during a catchment group meeting (top right) and the release of dung beetles (bottom right).

The most extensive mitigation efforts were implemented at site RVS-1 near Rai Valley township (*Figure 8*). Monitoring data show significant improvements in Nitrate and Ammoniacal Nitrogen as well as Dissolved Reactive Phosphorus concentrations, demonstrating the effectiveness of fencing and riparian planting. However, E. coli levels remain high, indicating that further fencing is needed, particularly around small tributaries and critical source areas such as swales. Additional fencing would likely lead to further reductions in Ammoniacal Nitrogen and Turbidity, which still show occasional elevated values not linked to rainfall.

Figure 8: Fencing and planning of large sections of the streams in the Rai catchment have resulted in measurable improvements in water quality at site RVS-1.

Recommendations and Conclusion

The monitoring results clearly demonstrate that targeted mitigation actions, particularly fencing and riparian planting, can lead to measurable improvements in water quality. These improvements are most evident at sites where extensive work has been carried out, such as RVS-1, and where landowners have actively engaged with the project, such as WPC-3.

It is essential that mitigation monitoring continues, particularly at sites where further mitigation actions are planned and where mitigation actions, such as riparian planting have not yet developed to their full extent and associated mitigation potential. Demonstrating tangible improvements in stream health builds trust and encourages further participation. It can also strengthen the case for ongoing investment in ecological restoration and therefore the continuation of the Te Hoiere project. This ensures that project structures and relationships that have been developed are not lost.

As funding is limited, it is important that the monitoring captures sites where mitigation actions have been implemented or are about to be initiated. Monitoring sites in areas with no current mitigation actions and for which actions are unlikely to occur in the near future, should be discontinued and replaced with sites where mitigation actions have occurred or are planned. Discontinued sites can be monitored again in the future if the situation changes.

When adding new sites, those included in the 2020/21 baseline study should be prioritised. This allows for direct comparison and increases the likelihood of detecting meaningful changes. However, if sufficient lead in time allows adequate monitoring before mitigation actions are put into place, a completely new site could also be chosen.

Depending on the mitigation measures implemented, other parameters or monitoring methods might also be included for relevant sites.

A formal review of the programme should be carried out at least once per year. This ensures that the monitoring is fit for purpose; specifically, that it remains aligned with project goals and adapts to evolving needs.

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Appendix

Results of the Wilcoxon "signed-ranked" Test comparing 2020/21 baseline monitoring data to the 2023/25 effectiveness monitoring.

Table 2: P-values for Wilcoxon Test. Cell are coloured based on associated uncertainty category in Table 1 of the report

Parameter/Site	TKO-7	RIM-2	RVS-1	LBS-2	PLRT-7	KTRT-1	WPC-3
Nitrate-Nitrogen N	0.241	0.492	0.031	0.275	0.106	0.638	0.058
DRP	0.528	0.126	0.059	0.646	0.308	0.011	0.362
Turbidity	0.037	0.756	0.109	0.520	0.465	0.365	0.195
E. coli	0.365	0.894	0.834	0.206	0.120	0.067	0.108
Ammoniacal N	N/A*	0.599	0.142	0.475	0.221	0.385	0.075
pH	0.429	0.007	0.854	0.021	0.014	0.370	0.553

* All values below detection limit

For Ammoniacal N p-values could not be accurately calculated due to a large number of ties