ACTION PLAN: BREAM BAY CATCHMENT

FOR: PIROA CONSERVATION TRUST

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1 INTRODUCTION

Piroa Conservation Trust (PCT) is primarily a conservation group with a vision for nature and people flourishing together from the hills to the sea. The community-led activity includes predator and invasive weed control and healthy waterways. The catchment group is focused on the Bream Bay catchment, which comprises the Ruakākā River, Waipu River and surrounding catchments. PCT is concerned about the health of the waterways and would like to improve the quality of the waterways and prevent it from deteriorating further. The issues identified, include erosion, high sediment levels and poor water quality.

PCT commissioned BEnviro (a Babbage Company), through the Access 2 Experts Programme from the Ministry for the Environment (MfE) to assess different sites of concern distributed through the catchment and provide recommendations in a succinct site-by-site Action Plan.

The primary focus of this document is to deliver solutions and a direction for the community group towards an integrated catchment management approach that will help them achieve their objectives. The document collates existing information provided by PCT, scientific literature, as well as comments from the appointed MfE experts post-site visit.

2 METHODOLOGY

A comprehensive scientific review was undertaken, primarily centred on case studies from New Zealand (NZ). This research scope was later broadened to encompass examples from Australia and Europe, where comparable climates prevail. Additionally, a site visit was arranged in collaboration with the PCT catchment coordinator. To gather valuable insights from the visit, a field app was employed to collate information alongside voice recordings and photographs at each location. To aid accessibility, ArcPro was utilized to create maps and Story Maps from GIS were developed as a digital platform for the group members to easily access and retrieve information.

3 DESKTOP REVIEW

3.1 SCIENTIFIC REVIEW FOR CATCHMENT MANAGEMENT

The following research items offer an overview of the principles linked to the suggestions that BEnviro is presenting in the Action Plan Guidance

3.1.1 Riparian Retirement and Buffer Zones

Best practices and scientific guidance for improving ecological value and water quality through riparian management vary depending on the watershed use and objectives. For Bream Bay, we focussed on livestock farming and forestry plantations.

For cattle farming, the relatively straightforward method of limited pasture retirement can significantly enhance sediment control and nutrient run-off mitigation. The mitigation increases according to the retirement buffer width, which usually varies from three to fifteen meters, on either side of the stream. Such effects have been widely demonstrated in New Zealand from studies by Williams, 1983; Smith, 1989; AgResearch-NIWA. 2000; Parkin, 2004; McKergow, 2016. Even where the riparian buffers are simply ungrazed grass, bank erosion decreases, especially in small streams (Williamson *et al.*, 1992). The grass cover also works as a filter, retaining soil, and faeces, as well as reducing contamination with microbes (Collins *et al.*, 2004), such as *E. coli*.

Nutrient management is critical for maintaining freshwater quality, as it will reduce toxic algal blooms, nuisance macrophytes and eutrophication. Phosphorus often moves through the catchment with faeces, biomass and soil, while nitrogen-based nutrients are more soluble and can be easily transported to and through the water table. Therefore, to mitigate nitrogen runoff, two main approaches can be considered: (1) capture by vegetation planted in the riparian margin and (2) in-stream immobilisation and denitrification by aquatic or semi-aquatic features.

The former approach (riparian planting) is the most effective way to reduce nutrients from entering the waterways. Planting native species along riparian buffers can achieve good nitrogen capture (Franklin *et al.*, 2015), especially when mixing woody species with monocots (sedges, flaxes and grasses). This is useful for buffers in both crop and livestock areas and for perennial, intermittent (temporary watercourses) or even artificial drain channels, depending on local management plans.

Mixed planting can also result in a diverse shading effect along the watercourse, which is favourable for the water temperature and in-stream nutrient immobilisation and denitrification (McKergow, 2016), which will be further explained below.

Regarding forestry in steeper headwaters, Baillie and Neary (2015) established that in NZ, riparian buffers are effective for stream shading, water temperature control, and lesser input of organic matter (logging slash). In addition, there will be mitigation of nitrate runoff after harvesting; reducing the magnitude of alterations on periphyton and benthic macroinvertebrates in stream communities. However, buffer strips of a row of remaining trees, were ineffective in retaining fine-suspended sediment during harvesting, especially along skid trails (Graynoth, 1979).

Overseas, similar effects were reported for forestry. In Sweden, Chellaiah and Kuglerovan (2021) found that a riparian buffer of forestry trees does not provide significant retention of fine sediments, but it provides positive effects on streams by shading, controlling logging slash, and maintaining freshwater trophic state and diversity. However, the same authors found various outcomes from different catchment areas, slopes and geologies, concluding that site-specificity is required for determining the best buffer widths.

3.1.2 Knowledge of riparian buffers width and length

Site-specific planning for buffer widths should include different factors such as catchment context, slope, soil, land use, ecological context, and hydrological resilience. These details should be considered when planning the final riparian margin widths along the watercourses in the Bream Bay catchments. BEnviro provides below a review of buffer width illustrating the general trade-off between the extent of productive land retired and investment for riparian protection, versus the benefits they provide to the overall ecological context.

In a meta-analysis of dozens of studies overseas, Lind *et al.* (2019) found interesting width values for the effectivity of different services, as per Figure 1. The number of ecological services increases with the buffer width (Figure 1), and the catchment groups should ultimately decide the width of riparian margin based on their general goal for each area, in collaboration with the different landowners. BEnviro is suggesting, in general, a riparian margin of fifteen metres utilising mixed planting, although if allowed, a wider buffer should be opted for.

According to the scientific literature, fifteen metres should be enough, in most cases, for nutrient and sediment control, and organic material. The fifteen-metre riparian width should be enough for the outcomes desired by PCT for this project regarding water quality and corridors for terrestrial dispersion. At present, the terrestrial biodiversity still needs to rely on (native) forest mosaics, if a connection can exist linking these mosaics, then there is a higher chance of species mobility.

Furthermore, the length of riparian buffers needs to be addressed since Brumberg *et al.* (2021) demonstrated that fifteen-metre-wide riparian margins can be effective for water quality when they reach at least 500 metres in length.

That way, the further the riparian buffers can be extended for the better for preventing pollutants from reaching fresh water. The ideal scenario is a continuous headwater to the sea riparian margin McKergow, (2016). Once pollutants are in waterbodies, their management and mitigation are limited and require even more effort, costs and risks, as presented below.

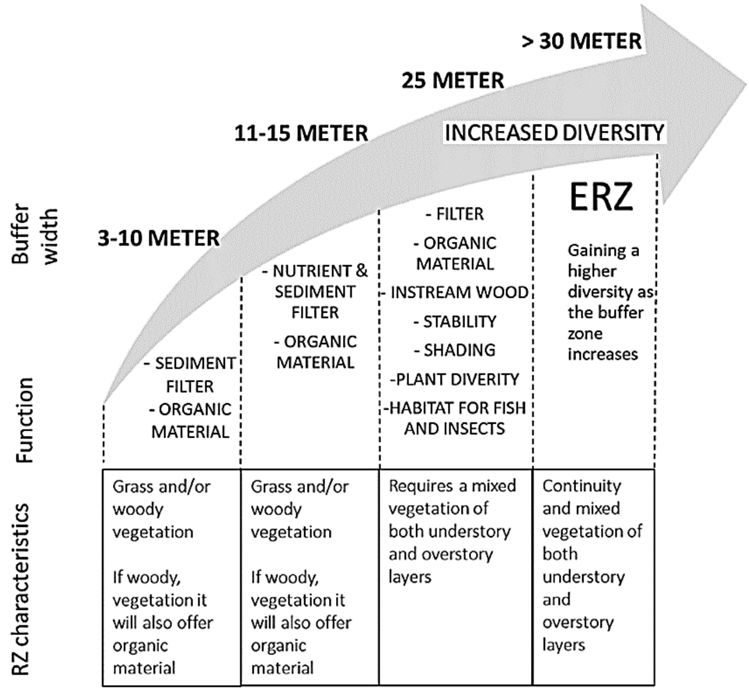


***Figure 1** . Conceptual framework extracted from Lind et al. (2019), whose original legend says: 'The 'step-by-step ERZ framework' combines the concept of "Ecologically Functional Riparian Zones", the literature review and results from the meta-analysis. RZ=Riparian zones.'*

Riparian zones of 3–10m with woody vegetation (i.e. trees and/or shrubs) will control sedimentation and increase organic material input.

Riparian zones of 11–15m with woody vegetation will have the same function as the narrower zones but will also filter nutrients. Steeper slopes and finer soils can be compensated for by adjusting towards a wider buffer width within each category. Consideration also needs to be taken of the specific hydrological pathways.

Riparian zones over 25m will also be sufficient to re-generate larger trees and consequently shade, influence the water temperature, and ensure bank stability. The floral and faunal diversity will increase with increasing buffer width, but if a high diversity of both plants and animals is the main goal, in many cases more than a 30m wide zone on both sides of the waterway is needed.

Below we provide a summary diagram displaying the benefits of a wider riparian margin.

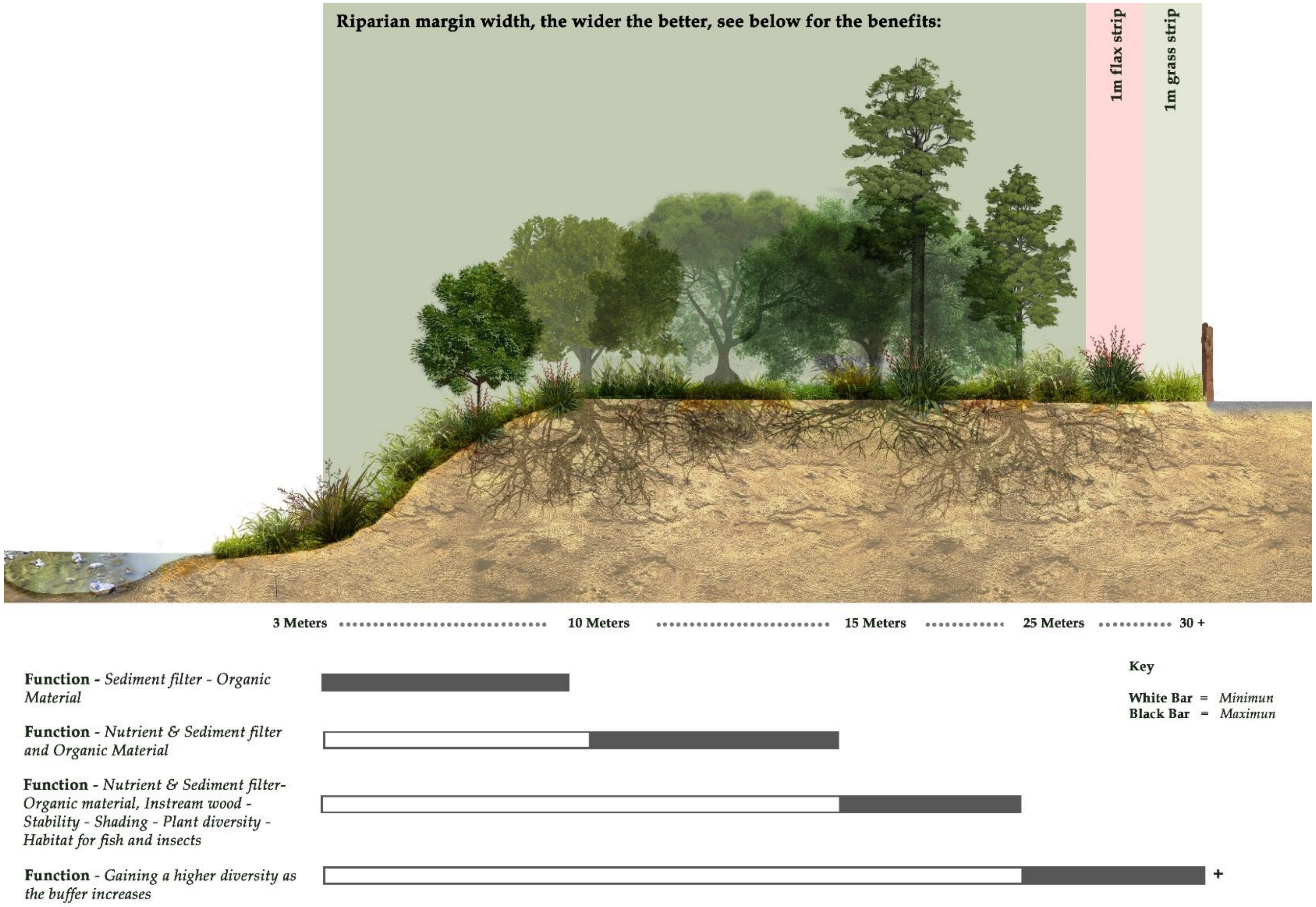


Figure 2 BEnviro's modified conceptual framework extracted from Lind et al. (2019)

3.1.3 Effects of wetlands and saturated organic soils on nutrient and sediment control

Once nutrients leak into the water table, there is a last natural biochemical barrier before they flow to the streams. This happens when the water table surfaces in springs or wetlands near the streams. There, it forms an aquatic-terrestrial zone that can remove excess nutrients coming from the catchment. However, once nutrients enter flowing water, further sequestration is very hard to achieve.

Cooper (1990) found that in the Waikato, stretches of organic soil at the bottom of riparian zones, cause most of the nitrate removal in a stream catchment. Nguyen *et al.* (1999) found similar results in a NZ hilly sheep-grazed catchment. Still, in Waikato, Rutherford and Nguyen (2004) also demonstrated that wetlands promote enhanced water residence time, vertical diffusion and some removal of nutrients and some nitrate removal, even on occasion of surface flows. For an experimental constructed wetland, Hoang *et al.* (2023) found an annual average nitrate sequestration of 61%. The best performance occurs at low flow (up to 80%) and still maintains around 20-40% during the higher-flow periods.

The potential of a given wetland to immobilise and process nutrients is limited; and, depends on the hydrology and land use of the area. Storms can naturally mobilise sediment and nutrients contained in the wetland, which becomes a temporary source in such events (Nguyen *et al.*, 1999). However, cattle access to wetlands can have more intense effects. For a catchment in the Taupo Region, McKergow *et al.* 2012 found the release of nitrogen during cattle grazing periods in wetlands was nine times greater than under storm conditions.

Another important trait for implementation of nitrogen removal by wetlands and saturated soils, is denitrification. This occurs predominantly under anoxic conditions and high carbon (biomass) content (Cooper, 1990). When planning wetland restoration for nutrient control, it is important to consider the effect of storms, wind and other forces on resuspending layers of sediment. This can result in temporary high nutrient, biomass and biochemical oxygen demand downstream, affecting fish, macroinvertebrates, and other aquatic organisms, or even water use for humans and terrestrial animals. Buffer planting around wetlands is strategic to avoid such issues, reducing surface flow and winds.

3.1.4 In-stream nutrient sequestration *versus* shadowing

Aquatic ecosystems have some resilience around absorbing nutrients and increased biomass, although the threshold is unique for every case and circumstance. Algae growing (periphyton) on the bottom of shallow, clear streams are responsible for nutrient sequestrating (McKergrow *et al.*, 2016), and are limited in both time and scale.

A stream receiving extra nutrients promotes plant growth in the floodplains, which can potentially reduce the amount of light available for photosynthesis in the stream, limiting periphyton growth and compromising nutrient sequestration within the stream. Howard-Williams and Pickmere (2010) demonstrated this effect in the Whangamata Stream, NZ.

Mixed planting in the riparian buffer zones can be the best option for balancing shadowing and in-stream nutrient removal (McKergrow *et al.*, 2016). They allow for a balance since different segments of the water bodies can receive different daily amounts of light according to the height of the tree canopy, bushes, and monocots (grasses, sedges and flaxes) planted. Shadowing has positive effects on aquatic biota regarding temperature control, at the same time as capturing nutrient runoff.

The non-planting alternative and keeping the *status quo* will: simply maintain high instream temperatures in summer; lower instream temperatures in winter; potential sedimentation in streams which impact on microhabitats and aquatic species; lowered ability for aquatic vegetation to process the excess of nutrients and bank instability.

3.1.5 Positive Outputs Expected

As per the paragraphs above, the implementation of riparian buffers should result in better output for water quality, freshwater diversity, and terrestrial connectivity. The extension of planting affects such outcomes since continuous stretches are required for both pollutant run-off control and for the integration of ecological corridors for terrestrial biota.

Positive effects on fish are also expected since they require diverse resources and microhabitats are only available in healthy systems. In fact, fish and macroinvertebrates could work well as flag species for monitoring the improvement in ecological value obtained through the proposed management.

Based on such assumptions, the details for each case we cover *in situ* are presented in Section 4: Site-Specific Action Plan.

3.1.6 Environmental Management Plans

In the Bream Bay catchment, there are multiple companies that fall under the Hazardous Activities and Industries List (HAIL) category. These companies have been designated as HAIL because they have the capacity to store hazardous substances. If not properly managed, these substances pose a threat to aquatic ecosystems as they can enter the stormwater network, streams and rivers, and ultimately reach the beach.

HAIL sites are required to possess and adhere to Environmental Management Plans (EMPs) compiled by suitably qualified professionals. These plans have a crucial role in promoting environmental sustainability and ensuring responsible handling of waste by high-risk companies that may discharge pollutants into stormwater. The primary objective of these plans is to minimise any negative impacts on the environment. By diligently following these plans, companies can demonstrate their commitment to safeguarding the environment and preventing the degradation of land and water resources.

It is imperative for these types of companies to have an EMP in place and adhere to it to ensure proper storage of contaminants, correct spill response, appropriate waste management, appropriate stormwater management, etc.

BEnviro recommendation is for PCT to communicate with the relevant Council to ensure that auditing of these sites is being conducted and that the sites are operating based on their EMPs.

4 CATCHMENT MAP

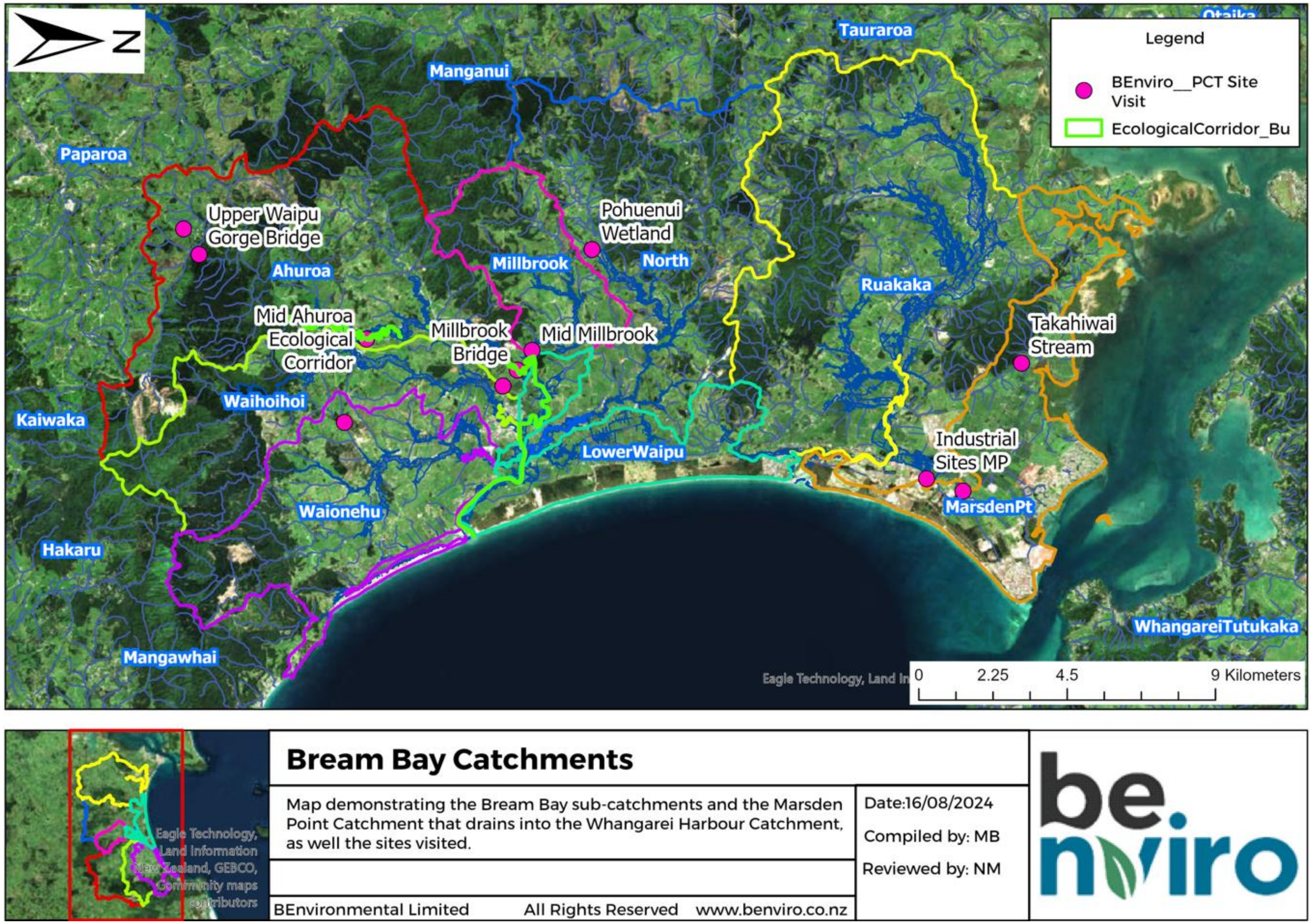
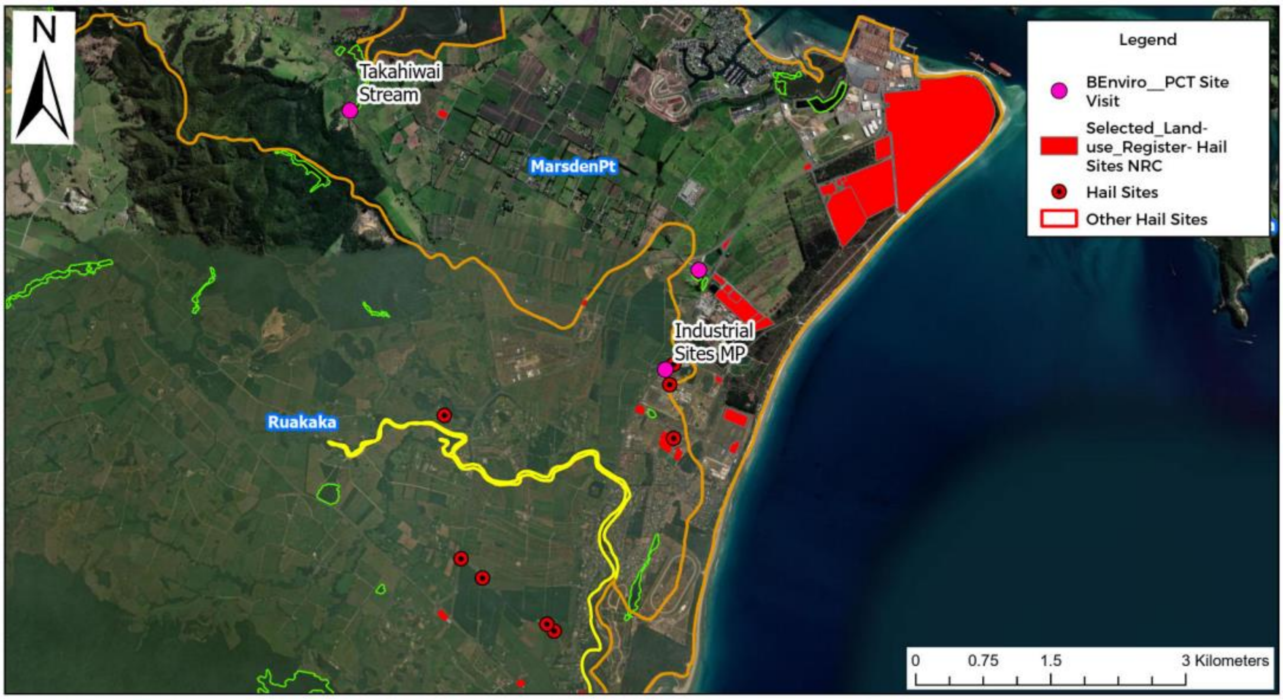


Figure 3 shows the map of the Bream Bay Catchment, including its seven sub-catchments, and the Marsden Point Catchment which drains into the Whangārei Harbour catchment.

5 SITE SPECIFIC ACTION PLAN

TO:	**Piroa Conservation Trust (PCT)**	**DATE:**	**16 August 2024**
ORGANISATION:	**BEnviro (a Babbage Company)**		
MfE EXPERT:	**Mariana Basilio (PGCEN- Stormwater Management; PGDipScTch- Aquatic Ecology, BSc- Geography & Environmental Science)**		

ACTION PLAN: INDUSTRIAL SITES MP



Industrial Sites MP

Map demonstrates HAIL sites distributed through the lower areas of the Ruakaka and Marsden Point catchments.

Date:25/06/2024
Compiled by: MB
Reviewed by: NM

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Address:	468 Marsden Point Road, Ruakaka, Northland, 0171
ID:	Industrial Sites MP
Catchment Name:	Ruakaka
Main Issues Found in the Reach/Catchment:	Water Quality (chemical spills), Habitat Loss, Artificial Drainage
Status of Work by Community Group(s)	New

Community Group Comments:	PTC has not thought about these areas as one that could be addressed. This area was raised by one of the experts.
Current Biodiversity Value (Including Catchment Context)	This area is in the low-lying areas of the Ruakaka catchment. It comprises of a dune/wetland ecosystem that has undergone significant alterations and modifications. Industrial activities and road construction have encroached upon parts of the area. The dune/wetland ecosystem is now scarce and only a few habitat remnants remain. The area appears to have been drained using artificial channels.
Potential Biodiversity Value (Including Catchment Context)	If restored this dune/ wetland ecosystem could provide suitable habitat and services for several migratory bird species and herpetofauna.
Enhancement Comments from Specialists:	The main opportunity in this area is promoting the management of HAIL sites and Stormwater High-Risk Facilities. Such facilities/companies need to have available an Environmental Management Plan (EMP), or Pollution Control Plan (PCP) prepared by a suitably qualified practitioner to ensure they adequately manage stormwater runoff. PCT could follow up with the relevant council(s) to ensure audits of these facilities are held and that these sites have EMPs or PCPs, and that these are followed. Promote events to bring awareness on the impacts of pollution from stormwater in high-risk stormwater facilities. Another opportunity in this area is promoting dune and wetland restoration
Number of Hail Sites (Bream Bay Catchment):	Over 40

Success Measure Recommended by Specialist:	Engagement rate from industrial facilities to the awareness events.

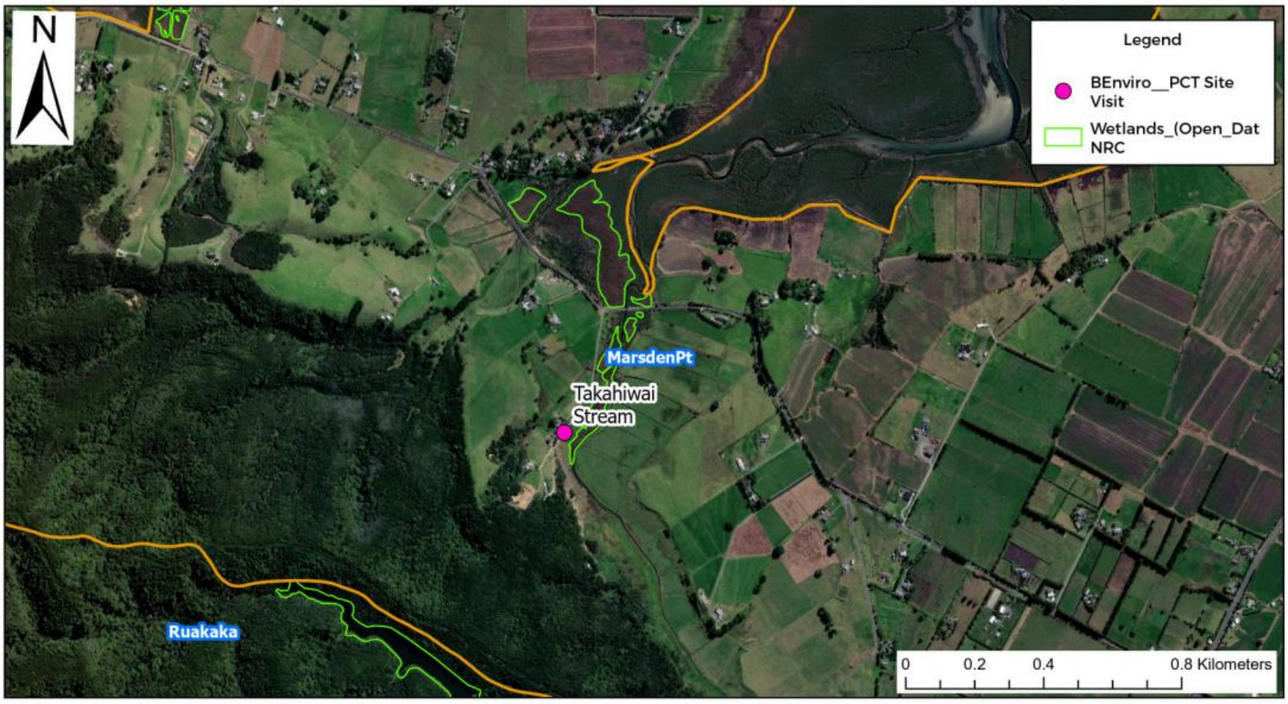
Photo(s)

Figure 4 Photo displaying an industrial facility in the low-lying areas of the Ruakaka Catchment.

Figure 5 Photo displaying an artificial channel, or stormwater drains alongside Marsden Point Road, Ruakaka.

TO:	**Piroa Conservation Trust (PCT)**	**DATE:**	**16 August 2024**
ORGANISATION:	**BEnviro (a Babbage Company)**		
MfE EXPERT:	**Dr. Neil Mitchell (PhD- Ecology; MSC- Ecology; MA- Botany)**		

ACTION PLAN: TAKAHIWAI STREAM



Takahiwai Stream

Map demonstrates site location for future fencing and planting in the Marsden Point catchments.

Date:25/06/2024
Compiled by: MB
Reviewed by: NM

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Address:	219 Takahiwai Road, Takahiwai, Whangarei, Northland, 0171
ID:	Takahiwai Stream
Catchment Name:	Marsden Point
Main Issues Found in the Reach/Catchment:	Stock Access, Flooding, Artificial Drainage, Pampas
Status of Work by Community Group(s)	Ongoing
Community Group Comments:	The local iwi have engaged in significant planting activities, and they are also planning to fence most

	watercourses. Their objective in meeting with the experts was to discuss suitable plant species that can provide food for birds throughout the year. They are seeking recommendations on which specific plant species to plant between the fence and watercourses.
Current Biodiversity Value (Including Catchment Context)	The area is a tidal ecotone comprising a mixture of wetland, mangrove, salt marsh, freshwater springs and estuary ecosystems located within the gazetted Rohe Moana of Patuharakeke. According to the landowner, several species of both aquatic and terrestrial are found in this area. This area has redfin bullies (*Gobiomorphus huttoni*), mullets (*Aldrichetta forsteri* and/or *Mugil cephalus*), eels (*Anguilla* spp.), inanga (*Galaxias maculatus*), smelt (*Retropinna retropinna*), banded kokopu (*Galaxias fasciatus*), and shrimps.
Potential Biodiversity Value (Including Catchment Context)	This region possesses immense ecological significance due to the convergence of marine and terrestrial habitats. It serves as a resting place for various seabirds, including shag and bitten, which may find refuge in the surrounding trees.
Enhancement Comments from Specialists:	As part of the restoration of the wetland the land owner could consider planting the following species inside the fenced areas alongside the streams: *Cyperus ustulatus*, *Plagianthis regius*, Kōwhai (*Sophora* spp.), *Carex secta*, *Carex virgata*, *Baumea articulata*, *Baumea juncea*, *Baumea rubinosa*, *Cordyline australis*, *Phormium tenax*, *Eleocharis sphacelata*, Kahikatea (*Dacrycarpus dacrydioides*), *Schoenoplectus validus*, Tītoki (*Alectryon excelsus*), Karaka (*Corynocarpus laevigatus*), and Kohekohe (*Didymocheton spectabilis*).

Success Measure Recommended by Specialist:	Fencing and plant establishment.

Photo(s)

Figure 6 Photo of the flat area at the bottom of the Takahiwai Stream.

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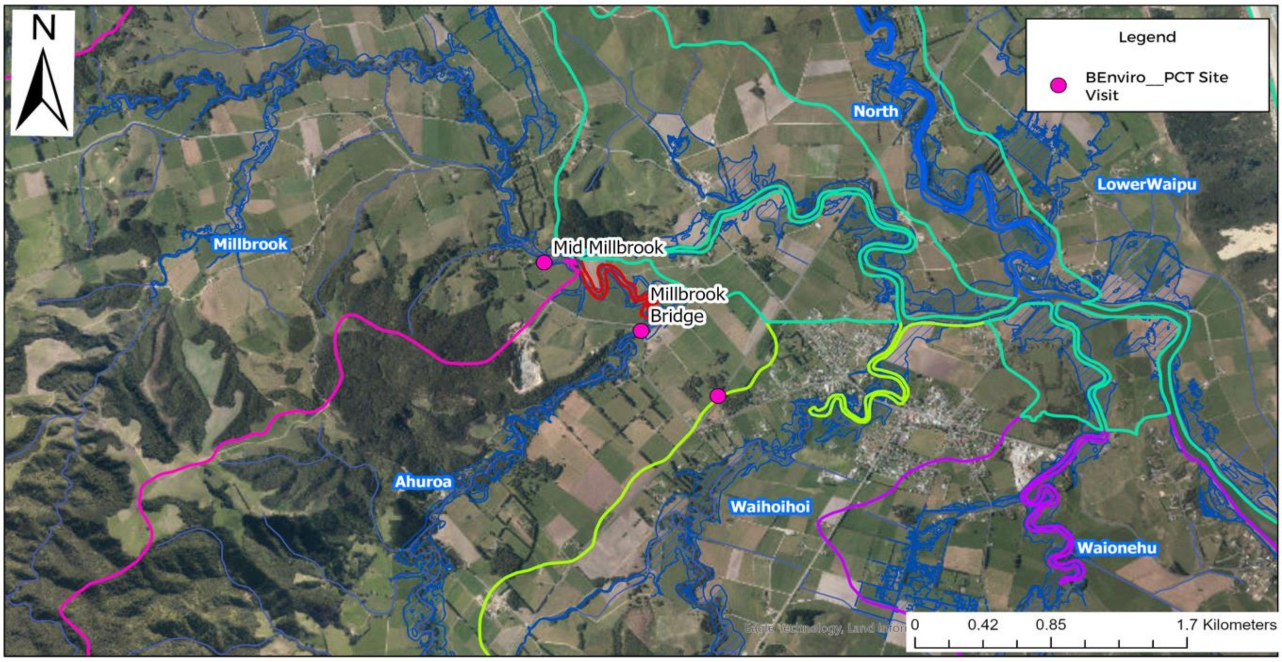
ACTION PLAN: MILLBROOK BRIDGE



Millbrook Bridge & Mid Millbrook Spawning Site

Map demonstrates 2 sites where spawning have been identified.

Date:15/08/2024
Compiled by: MB
Reviewed by: NM

Address:	Millbrook Road, Waipu, Northland, 0582
ID:	Millbrook Bridge
Catchment Name:	Ahuroa
Main Issues Found in the Reach/Catchment:	Water Quality (Sedimentation), Bank Stability
Status of Work by Community Group(s)	Ongoing
Community Group Comments:	PCT is presently overseeing the spawning environment and the associated riparian vegetation composition. Experts were brought to this location

	with the aim of increasing the number of areas known as suitable for spawning habitats.
Current Biodiversity Value (Including Catchment Context)	The Ahuroa River in this location provides for spawning habitat. This location is found downstream from a catchment that requires several catchment management approaches, such as environmental compliance of industries, and improvement of discharge from pastoral land.
Potential Biodiversity Value (Including Catchment Context)	This area has the potential to provide suitable spawning habitat for Galaxidae. However, an all-encompassing catchment management approach is needed, to improve water quality.
Enhancement Comments from Specialists:	To enhance the quality of water in the upper catchment, which ultimately flows into the lower regions where spawning occurs, it is crucial to enforce compliance among industries situated in the upper catchment area. It is recommended that the PCT engage in dialogue with the Northland Regional Council to ascertain whether monitoring of these companies is being carried out and if the operators are adhering to their respective Environmental Management Plans (EMPs). If the quality of water can be enhanced, it has the potential to increase spawning intensity, meaning that each female can lay a greater number of eggs due to reduced stress caused by poor water quality.
Success Measure Recommended by Specialist:	Water quality improvements and monitoring of spawning frequency yearly.

Photo(s)

Figure 7 Photo facing upstream, showing banks able to sustain spawning habitat through suitable microhabitats comprising of overhanging vegetation, leaf litter and macrophytes (both exotic and native).

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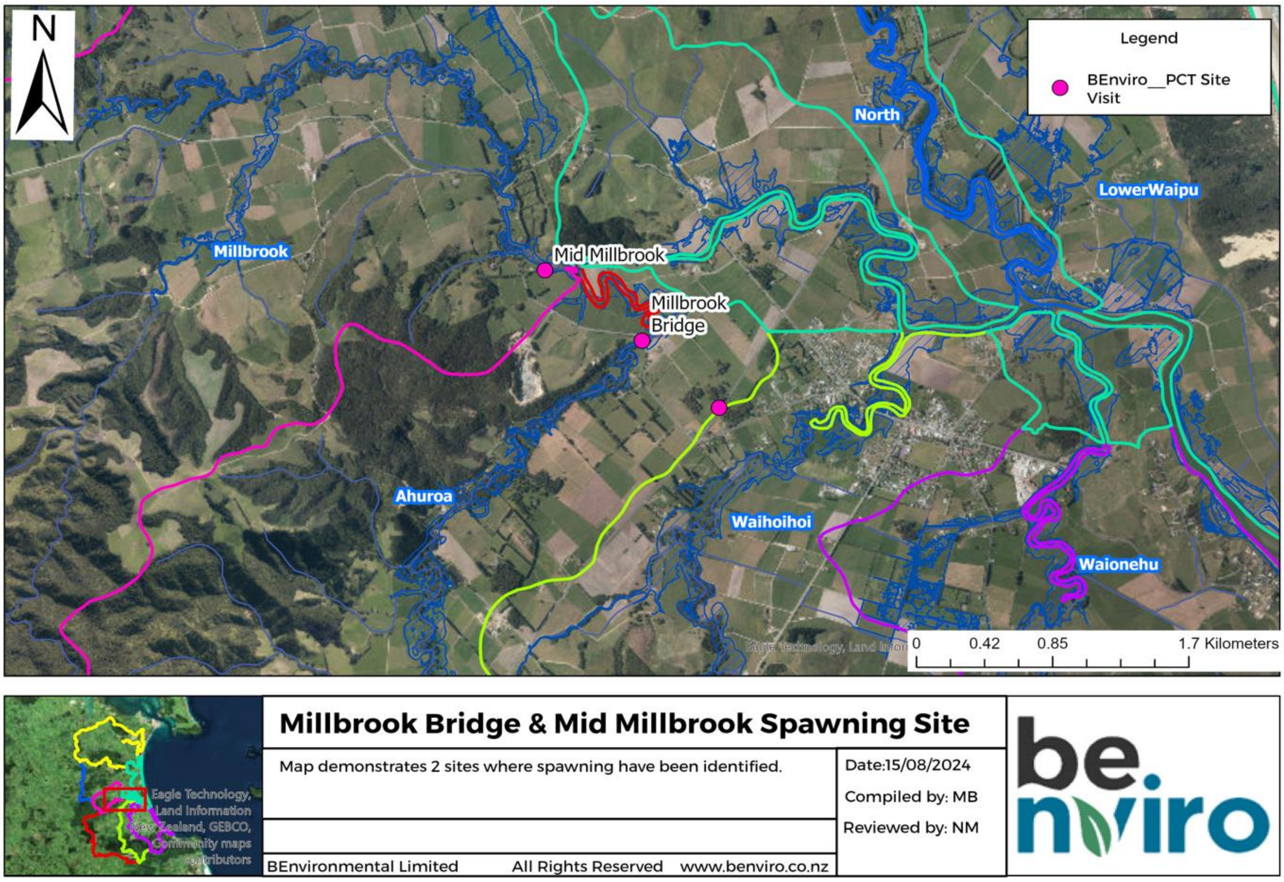
ORGANISATION:	**BEnviro (a Babbage Company)**		
MfE EXPERT:	**Dr. Neil Mitchell (PhD- Ecology; MSC- Ecology; MA- Botany)**		

ACTION PLAN: MID MILLBROOK SPAWNING SITE



Address:	174 Millbrook Road, Waipu, Northland, 0582
ID:	Mid Millbrook- Spawning Site
Catchment Name:	Millbrook
Main Issues Found in the Reach/Catchment:	Planting density for trees was too high.
Status of Work by Community Group(s)	Completed
Community Group Comments:	The catchment group has said that measures have been taken to control pests, specifically rats and mice.

	Regarding the comment by Dr. Mitchell on planting density, the group thinks that the suggestion by Neil can be a solution to expand and distribute resources (*i.e.* planting) over a larger area. This could be achieved by planting lower density and allowing birds to play a more active role in the restoration. This area has been restored, and fish eggs have been found. The group also expressed their concern in deciding whether to leave the spawning sites untouched or proceed with planting in the riparian zone.
Current Biodiversity Value (Including Catchment Context)	This section of the watercourse is located at the downstream end of the Millbrook River. The catchment is one of the smallest of the Waipu Catchment (18 Km^2). The upper catchment is mostly surrounded by pastoral land, with varying riparian margin widths. According to Ballinger (2012) the levels of phosphorus, turbidity and *E. coli* coming from the Millbrook catchment is non-compliant.
Potential Biodiversity Value (Including Catchment Context)	This portion represents a small area of riparian buffer, which has the potential to become well-established over time through the growth of dense vegetation. It serves as a buffer for runoff from pastoral activities and also allows for increased spawning without any interference from riparian planting. In order for the spawning habitat to be more successful, then improvements in water quality are necessary.
Enhancement Comments from Specialists:	The catchment group recently engaged in riparian planting at this particular location a few months back. A team of experts was brought to this site to offer their insights on the best practices for

	riparian planting. One of the experts pointed out that the density of tree planting was too high. The rationale behind this observation was that trees require sufficient space to grow, and in order for understory species to flourish, they need access to light. When the density of large trees becomes excessive, it ends up overshadowing others, leading to a restoration dominated solely by the canopy with minimal understory and ground cover. To enhance bird diversity, it is essential to select tree species that offer fruit and nectar, a variety of growth habits, which will create a diverse range of habitats. In terms of nutrient removal, it was mentioned that mixed planting can enhance the capacity for nutrient uptake in both riparian and periphytic aspects. Additionally, it was recommended to establish a 1m buffer of grass followed by a row of flax (specifically Harakeke, *Phormium tenax*) to reduce the nutrients of pastoral runoff. In terms of species, Dr. Mitchell recommends Coprosmas as they thrive in rich soils and attract birds very quickly. The expert also said that wider spacing promotes flowering and makes management easier. Inanga spawning occurs between April and July (Franklin *et al.*, 2015). The ideal timing for the incubation of the eggs for *Galaxias maculatus* is one to two weeks (Semmens and Swearer, 2011). This suggests that planting (if near the riparian margin) should occur later in the planting season, or at least two weeks after finding the eggs.
Success Measure Recommended by Specialist:	**In future plantings consider lower canopy density.**

Photo(s)

Figure 8 photo showing riparian planting undertaken by catchment group facing upstream.

Figure 9 photo showing riparian planting undertaken by catchment group facing downstream.

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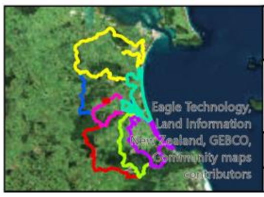
ACTION PLAN: POHUENUI WETLAND



Pohuenui Wetland

Map demonstrates a wetland within the North Catchment.

Date:16/08/2024
Compiled by: MB
Reviewed by: NM

Address:	55-677 Helmsdale Road, Waipu, Northland, 0582
ID:	Pohuenui wetland
Catchment Name:	North
Main Issues Found in the Reach/Catchment:	Cattle access; Lack of riparian planting
Status of Work by Community Group(s)	Forecasted

Community Group Comments:	PTC would like to increase the habitat condition of the wetland for inanga and bitten. Their goal in this area is to enhance the habitat for these species. To achieve this, they have devised a plan to plant raupō and create a pond within the wetland, to increasing habitat diversity. This will be of particular value during drier summer months. Additionally, they hope to improve connectivity by planting riparian vegetation connecting to the watercourse downstream (from the road crossing).
Current Biodiversity Value (Including Catchment Context)	This section consists of a wetland situated within a valley. It is probable that the wetland is a Natural Inland Wetland, which is protected and has restrictions on activities. Throughout the area surrounding the wetland, there are fully grown trees; however, they are located at a distance from the wetland and do not cast any shade on it. The upstream catchment (viewed from an aerial image) appears to be a combination of wetlands formed in the floodplain of a stream. Moving downstream, the wetland narrows into a watercourse that has been routed under the road through a pipe; this pipe according to the catchment group does not pose any barriers to fish. At the point where it intersects with the road (downstream of the culvert), it transforms into an open channel that has been recently planted with narrow riparian vegetation.
Potential Biodiversity Value (Including Catchment Context)	This area has a great potential to be used by fish as a feeding ground, and a refuge for bitten and other wetland bird species. The gradient of the slope also provides great habitat for herpetofauna. If riparian planting and fencing is provided, then these will

	allow for lower nutrient levels being discharged to the watercourse downstream.
Enhancement Comments from Specialists:	Instead of creating artificial holes through the wetland, which may resuspend sediment and may require consent, the specialists recommend PTC to include large logs through the wetlands. These logs can be placed in such a way as to reinstate a somewhat original flow path. It is important, however, to ensure that the logs are placed without creating a fish barrier. Lastly, the choice of logs should be opted to those that do not float easily and move with higher floods, otherwise, these can accumulate near the outlet of the wetland, adjacent to the road. In terms of plant species, the specialists recommend planting raupō (*Typha orientalis*) and sedges within the wetland, and kahikatea (*Dacrycarpus dacrydioides*) and swamp maire (Syzygium maire Kahikatea (*Dacrycarpus dacrydiodes*), Pukatea (*Laurelia novae-zenlandiae*), Flax (*Phormium tenax*), Cabbage tree (*Cordyline australis*), Mānuka (*Leptospermum scoparium*), Kōwhai (*Sophora fulvida*), Purei (*Carex secta*), Toetoe (*Carex virgata*), Karamū (*Coprosma* sp.) round the riparian margins of the wetland. It may also be beneficial to use logs to create an island, which birds can use as a refuge. When undertaking the restoration, consider fencing the wetland from stock. This will prevent the resuspension of nutrients and sediments from being discharged downstream.
Wetland Area (m^2):	9,450sqm
Riparian Area Around Wetland (m^2):	8,310sqm

Length of Riparian Downstream (m):	~190m
Success Measure Recommended by Specialist:	**Improve riparian buffer and connectivity.** **Increase habitat diversity.** **Exclude stock by fencing.**

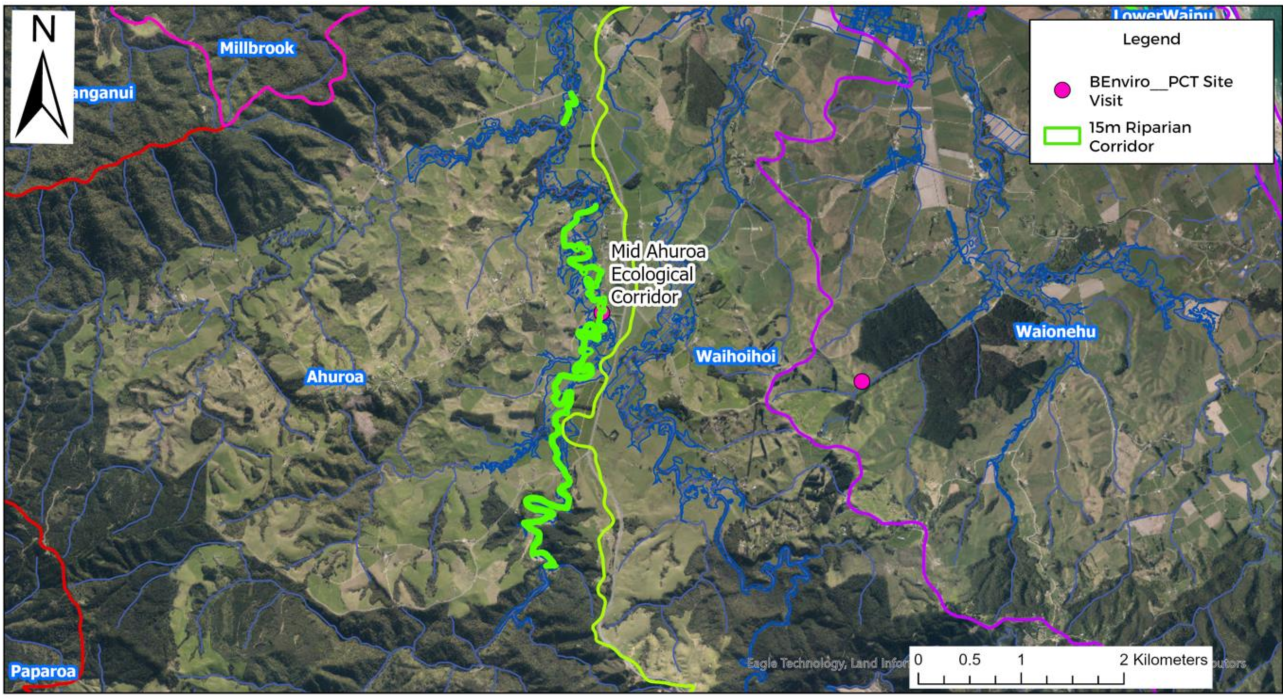
Photo(s)

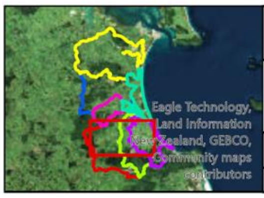
Figure 10 shows a photo of the wetland that is proposed to be enhanced.

Figure 11 shows the watercourse, riparian planting downstream from the wetland, and road crossing.

TO:	**Piroa Conservation Trust (PCT)**	**DATE:**	**16 August 2024**
ORGANISATION:	**BEnviro (a Babbage Company)**		
MfE EXPERT:	**Dr. Neil Mitchell (PhD- Ecology; MSC- Ecology; MA- Botany)** **Mariana Basilio (PGCEN- Storm Water Management; PGDipScTch- Aquatic Ecology)**		

ACTION PLAN: MID AHUROA ECOLOGICAL CORRIDOR





Mid Ahuroa Ecological Corridor

Map demonstrates the proposed Ecological Corridor, linking the Waipu Gorge Scenic Reserve with the lower catchments of the Ahuroa River.

Date:15/08/2024
Compiled by: MB
Reviewed by: NM

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Address:	4212 State Highway 1, Waipu, Northland, 0582
ID:	Mid Ahuroa Ecological Corridor
Catchment Name:	Ahuroa
Main Issues Found in the Reach/Catchment:	Erosion, Flooding and Weed Invasion
Status of Work by Community Group(s)	Ongoing
Community Group Comments:	The landowner is experiencing significant flooding and erosion along the banks. He had attempted to

	plant a riparian margin, unfortunately the attempts were unsuccessful in some areas due to large flow events. The strength of the water flow caused trees, and other plants to be washed away. He is now interested in replanting riparian margins but is unsure which species would survive in this particular area.
Current Biodiversity Value (Including Catchment Context)	This section sits within the transitional zone of the permanent meandering Ahuroa River. This river has high sinuosity, and, in this section, is prone to erosion and flooding. This stretch is an important connection between the upper catchment and the sea. The dispersion potential for herpetofauna and birds is currently compromised due to the discontinuity of the riparian vegetation.
Potential Biodiversity Value (Including Catchment Context)	Given the importance of this region as an ecological corridor connecting the upper catchment to the ocean, there is potential for it to serve as a vital pathway for various species. By establishing a continuous riparian buffer in this area, not only can we facilitate the movement of wildlife, but we can also help safeguard the riverbanks from erosion. The creation an ecological corridor will undoubtedly contribute to the overall biodiversity, services and erosion resilience to this reach. From a terrestrial perspective, a continued green corridor can allow for the dispersion of vertebrates' species such as: birds, reptiles and frogs. Due to the pastoral nature of the neighbouring catchment area, implementing a wide and extensive riparian planting scheme will lead to improvements in aquatic organisms. This is primarily due to the enhanced shading effect and increased nutrient absorption.

Enhancement Comments from Specialists:	Consider establishing an ecological corridor along this watercourse by fencing and planting a 15-meter-wide riparian margin on both sides. The specialists suggest the following native species: Pūriri (*Vitex lucens*), Kahikatea (*Dacrycarpus dacrydioides*), tītoki (*Alectryon excelsus*), lemon wood (*Pittosporum eugenioides*), Kowhai (*Sophora chatamica*), Ribbonwood (*Plagianthus regius*), lacebark (*Hoheria populnea*), Totara (*Podocarpus totara*) and flax. The trees should be planted at approximately 3-5m spacing to allow for spreading growth and deep root development. Ideally, planting goes from upstream to downstream, as this will best facilitate bank stability. In an actively meandering river such as the Ahuroa, there will always be problem due to erosion on the outside of bends. This is where the maximum force of the river is felt. Some form of in-stream energy dissipation such as provided by fallen trees can help. However, a hydrologists advice should be sought. Planting a 15 m wide riparian margin will enhance the ecological value of the surroundings, improve some services, such as: nutrient and sediment filtration, organic matter to support aquatic life (food and microhabitat), as well as aid in the stability of stream banks. Please, refer to Section 1, Review 1 for more information. It will also provide high nutrient uptake and shade the watercourse. Please ensure that the density of the tree planting allows for light to shine through the understory and ground cover, this will balance water temperature control and nutrient sequestration by periphyton.

Riparian Margin Area (m²):	~240,000m2 (8,000 m long x 15 m wide x 2 sides)
Length of Fencing and Riparian Margin (m):	8,000 m x 2= 16,000 m
Success Measure Recommended by Specialist:	**Improve riparian buffer and connectivity.** **Exclude stock by fencing.**

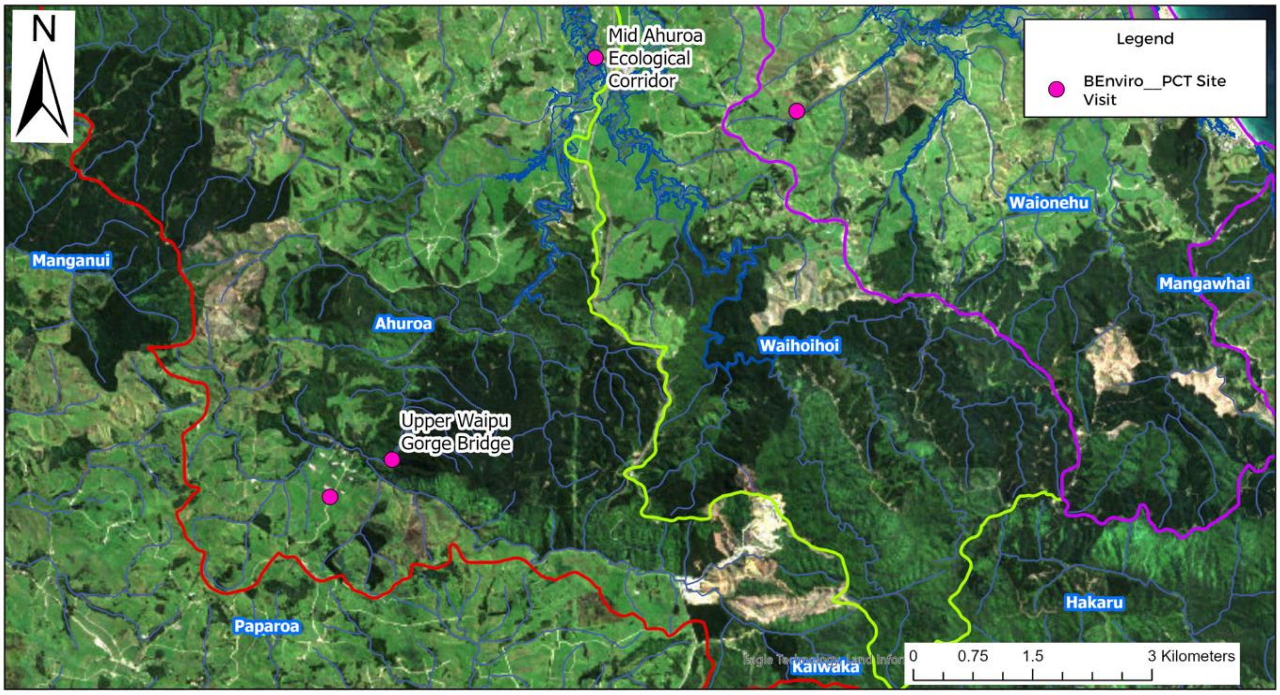
Photo(s)

Figure 12 displays a photo facing downstream of the Ahuroa River.

TO:	**Piroa Conservation Trust (PCT)**	**DATE:**	**16 August 2024**
ORGANISATION:	**BEnviro (a Babbage Company)**		

MFE EXPERT: **Dr. Neil Mitchell (PhD- Ecology; MSC- Ecology; MA- Botany)**
Dr. Fabio Rosa (BSc - Ecology and Conservation; MSc- Zoology/Animal Biology; MSc- Ecology and Biodiversity Conservation),
Mariana Basilio (PGCEN- Storm Water Management; PGDipScTch- Aquatic Ecology)

ACTION PLAN: UPPER WAIPU GORGE BRIDGE



Upper Waipu Gorge Bridge	
Map demonstrates the Waipu Gorge Scenic Reserve in relation to the Ahuroa catchment.	Date:15/08/2024 Compiled by: MB Reviewed by: NM
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Address:	Waipu Gorge Scenic Reserve
ID:	Upper Waipu Gorge Bridge
Catchment Name:	Ahuroa
Main Issues Found in the Reach/Catchment:	Water Quality and Pest Control

Status of Work by Community Group(s)	In Progress
Community Group Name:	Entered by Graham
Community Group Comments:	There has been trapping and toxin work in the Waipu Gorge as well as out further Waipu West. These trap and toxin networks can be seen on Trap.nz. PCT has sponsored these traps and toxin work with NRC and the landowners and found volunteers to help with the programme. They are concerned with the effects of pest species on the Northland brown kiwi (*Apterix mantelli*) which is suspected to be present in the area, and the Hochstetter's frog (*Leiopelma hochstetteri*). It is understood that ferret (*Mustela furo)* has been discovered, which could pose a danger to the potentially present kiwi population. PTC is also currently concerned with the potential discharges from the upper catchment, these being agribusiness, mining and forestry.
Current Biodiversity Value (Including Catchment Context)	The Brynderwyn Range has been identified as an Outstanding Natural Landscape in the Northland Regional Plan (Bazeley, 2021). The area has high biodiversity values that include extensive indigenous forest and shrubland. These habitats support a wide range of flora and fauna, including many threatened or significant species of plants, fish, frogs, lizards, bats and birds (Pierce, 2010). It is one of the most important Northland remnants. This area also provides a food source and habitat for a range of threatened and regionally significant animal species:

	• Hochstetter's frog. • Northland brown kiwi. • NZ pigeon and North Island tomtit • Longfin eels, banded kokopu and others (Pierce, 2010)
Potential Biodiversity Value (Including Catchment Context)	Being at the top of the catchment, once an ecological corridor is formed alongside the Aruhoa River, towards the sea, then this forest will be able to disperse species to the entire downstream environment. Through ongoing pest animal control, threats can reduce the impacts on the following native species: Northland brown kiwi (*Apterix mantelli*), kākā (*Nestor meridionalis*), red-crowned kakariki (*Cyanoramphus novaezelandiae*), pāteke (*Anas chlorosis*), grey-faced petrel (*Pterodroma gouldi*), and bellbird (*Anthornis melanura*) (Bazeley, 2021).
Enhancement Comments from Specialists:	Follow up with NRC to investigate whether the enterprises upstream (quarry, agribusiness, forestry) are complying with environmental regulations. Request for water quality data to be frequently monitored, to establish any water quality trends. Increase number of traps to ensure pest species are controlled.
Success Measure Recommended by Specialist:	Water quality- testing showing no effects from upstream activities. Effective pest management.

Photo(s)

Figure 13 depicts the discharge from the upper catchment. Water coming from the left side of the photo comes from the Ahuroa River upper catchment, and from the right side of the photo comes from the Piroa Stream.

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APPLICABILITY AND LIMITATIONS

RESTRICTIONS OF INTENDED PURPOSE

This report has been prepared solely for the benefit of PIROA CONSERVATION TRUST as our client with respect to the brief. The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such party's sole risk.

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Recommendations and opinions in this report are based on a couple of site visits, and variations can be expected throughout the year.