MURI ENVIRONMENT CARE

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MURI STREAMS, WATERWAYS & LAGOONS ECOLOGY PROJECT
INTERIM REPORT DATED JANUARY 2023

1.1 PROJECT SUMMARY

Key Environmental Problems being addressed

The topography of the Muri district of Rarotonga is unique & complex. The Muri environment for this Project extends (east to west) from the outer reefs defining Blue Pacific Ocean, to the mountain peaks of Te Rua Manga. North to south - from Vaikai Tapere to the Parengaru Stream outflow in Muri Lagoon.

Within this 1.75km reef to ridge hinterland x 3.5km coastline (6 square kilometer, approx) is historic Avananui harbour; the Muri lagoon, the 4 motus inside the lagoon; 241 residential homes; 30 growers agricultural flat lands; extensive Muri sandy beaches and 50 commercial prime accommodation & Villa style tourism complexes; the low hills rising to the peaks of our mountains; streams, wetlands, agricultural plane, and rivers.

And in our wet-season increased flood waters head down our valleys, across our lowlands, eroding stream banks causing extensive flooding. This leaves our lagoon with threatening sediment & nutrient loads. These nutrients have contributed to the growth of Algae Cupressoides in particular, while the sediment is lethal to coral and small lagoon fish , especially while breeding.

Proposed approach, Muri Ecology - Riparian Restoration Pilot Project

Vegetated riparian corridors are key to the healthy functioning of streams. Due to a lack of accessible knowledge and proven methods regarding the ecological restoration of Rarotonga's streams, work will require a whole-community effort with an emphasis on building out from small-scale successes. We propose a riparian corridor planting design process that is guided by landowners and is inspired by both local knowledge and scientific literature.

This project will aim to blend the best practices of riparian restoration from around the world with traditional ecological understanding to start to create some consensus around what healthy streams look like in Rarotonga.

Public buy-in into stream restoration work will continue to be key in building on the foundation of evidence and maintaining momentum. We believe we are earning greater public buy-in through both the successes in producing more native species all the time as well as high survival rates of our plantings at our restoration pilots site. We already have preliminary data suggesting improved ecosystem health via our small scale implementation and studies and we will continue to strengthen this feedback loop. We will continue to source knowledge and assistance from the community as this aspect will be essential to a number of long-term goals.

In order to learn more about what stream restoration might look like, we have recommended a diversity of interventions with a strong focus on observation in order to gauge the success of the agreed-upon interventions. Being given the choice of a menu of potential pilots, the plantings can better match the landowner's visions for the future while providing us with valuable foundational lessons. Meanwhile, we aim to establish a mix of locally desired plants that also have a robust, diverse, and complex network of roots that all together work towards:

- Stabilising stream banks,
- Reducing the flow velocity, sediment, and nutrient loads and
- Increasing native wildlife habitat

Being small and targeted studies, the scale is conducive to clear desired outcomes as well as effective and uncomplicated educational messaging.

The proposed pilot projects on the following pages were created to introduce some of the various themes that we are investigating in regard to stream restoration. We believe these pilots and similar studies will not only enhance our ecological understanding but also develop tools to communicate our actions and aspirations.

Project location – plus profile of sites – plus communities involved.

The MEC website shows our survey plans, pics, videos and google maps identifying the project location and profiles of our pilot sites & swales. In these specifically selected areas, we were influenced by a combination of factors, identifying the physical terrain appropriate to our GEF SGP 2022-23 Biodiversity project and the landowners who are resident on the streams and waterways properties who are therefore the influencers and the deciding factor in selection of our MEC engagement with our communities

Relevance to our country's NSDP and its relevance to the GEF SGP country program strategy (2015 -2018)

Our NSDP goals are closely aligned with the objectives of this Project. In particular goal 9 to Accelerate gender equality, empower all women and girls, and advance the rights of youth, the elderly and disabled; goal 10 to Achieve food security and improved nutrition, and increase sustainable agriculture; goal 11 to Promote sustainable land use, management of terrestrial ecosystems, and protect biodiversity; goal 12 Sustainable management of oceans, lagoons and marine resources; goal 13 to Strengthen resilience to combat the impacts of climate change and natural disasters; goal 14 to Preserve our heritage and history, protect our traditional knowledge, and develop our language, creative and cultural endeavours; and goal 15 to Ensure a sustainable population, engaged in development for Cook Islanders by Cook Islanders.

1.2 ORGANIZATIONAL BACKGROUND AND CAPACITY TO IMPLEMENT THE PROJECT

MEC is a well-supported and well-connected group with members and friends spread all throughout the Muri community and beyond. Our ongoing stream restoration efforts are seeing support from local tourism operations and resorts, government agencies as well community leaders. The following proposal has been the framework and roadmap used to reach out to more community members, government agencies and local businesses as well as engage and support school science programs.

PILOT IDEA 1: ECOSYSTEM ENGINEER SPECIES TRIALS

HYPOTHESIS: Some plants are more valuable for riparian restoration in Rarotonga than others, especially among the resilient pioneer species.

Some plant species have exceptional abilities to change their physical environments. In the early stages of riparian restoration on a site, species we have dubbed "Ecosystem Engineers" may be able to accelerate the return of key ecosystem functions. For example, Vetiver (*Chrysopogon zizanioides*) roots very fast and very deep. Planted in lines on contour and spaced in tightly packed 'hedges', Vetiver grass is a key tool for the foundation of our streambank stabilisation strategy. In this context, Vetiver-on-contour is basically a very inexpensive retaining wall that also offers a number of other ecosystem services. Over time, the grasses may or may not factor into the long term plan for that section of stream but have featured prominently in the early stages as an immediate 'triage' to stop the loss of the soil resource while also providing a number of other ecosystem services.

Trees can also be used for streambank stablisation. Prevalent in temperate climate riparian restoration is the use of the Salicaceae, a family that includes Willow and Poplar, known for quick root growth and easy establishment that can have instant effects of stream and riverbank stabilisation and flow dynamics. Due to Infrastructure Cook Islands' needs for clear flow in high level rain events, we will likely leave the actual streambanks to vetiver and other low profile and non-woody plants while focussing on establishing trees on the tops of the streambanks. Early attempts to establish trees in this zone have struggled due to mainly weed competition and wild animals so we are in the process of designing planting methods that factor in these challenges.

In addition to quickly rooting and penetrating deep into the soil, we want the pioneer species to also be contributing to improvements to the health and structure of the soil via nutrient uptake, cycling and increases in soil organic matter and soil biological activity. In order to conserve soil organic matter in the soil and prevent sheet erosion, it will be important to either incorporate mulching into new plantings or ensure that the soil is not left bare with ground covers as well. This will also help a great deal with the aforementioned weed competition challenges, especially at a site experiencing frequent disturbances.

Criteria for the ecosystem engineer trees were loosely based on being able to grow fast, high tolerance heavy pruning, thrive in less than ideal soil and potentially have multiple uses (desirable rooting behaviour, edible fruit, conservation value, etc.) Over time, these species will act as 'nurse' or support species to the increasingly complex and desirable suite of species in later stages that may require better soils or a bit of shelter/shade, etc.

PILOT IDEA 2: OBSERVATION-FOCUSED PASSIVE RESTORATION

HYPOTHESIS: An 'observation-first' approach with minimal interventions natural regeneration of sections of stream will give us numerous valuable insights.

These areas are essentially our 'control' plots that show what a hands-off approach to stream restoration would look like. The streambank areas adjacent to our planting area were recently channelized for the purpose of flood control. Though not ideal for the limitation of sedimentation, it has provided us with valuable information as to which species are Allowing streams to regenerate will give us important insights in how to work with and make small changes to enhance naturally occurring ecosystem recovery.

Alongside passive restoration, we still aim to experiment with selective weeding, targeted enrichment plantings and fertilization, mulch mats and tree guards, sheet mulching and other restoration techniques that have minimal disturbance on naturally regenerating plant communities. Any interventions would be minor and there would be a focus on learning and observation in these areas.

In addition to being useful control areas to put the more active restoration areas in context, this pilot project will be a very useful 'classroom' to teach about ecological restoration as well as engaging with the 'weeds'. We plan on running vegetation surveys alongside volunteers and potentially a classroom to educate ourselves and the community about the naturally regenerating plant species. With a better understanding of their forms and functions, we will be much more informed about how to work both with them or against them if deemed necessary.

PILOT IDEA 3: RETURNING NATIVES TO RAROTONGA'S STREAMS

HYPOTHESIS: Many plants and trees now only common in the mountains will reestablish in the lowlands with assistance and care from ecological restoration practitioners.

Being a relatively small island, arable and developable land is in high demand. Riparian corridors are a great place to establish native plants as they contribute to connectivity among wild spaces and also are already marginal lands that should not be used in agriculture or residential/commercial development. Because streams come from

the generally forested interior, riparian plantings can act as habitat corridors, expanding the ranges of native species assisting in the movement of species willing to re-introduce. Native species often are most suited to the climate and geology in which they evolved providing for long term resilience. Natives can often provide best for the needs of other native species, including endangered species with very specific needs, with which they have co-evolved.

In the first stage of planting, we are most concerned with stabilizing stream banks and we require pioneer species with fast growth and rapid root spread. We have made significant strides in building the capacity to propagate and include increasingly more natives into the planting schemes. Provision of landscape-scale revegetation efforts using native species requires a number of systems and infrastructure that are currently in their infancy.

As we have grown and cared for all of these new native plants in a nursery setting, we have gained valuable insights on their feasibility/difficulty as a nursery species as well as how they might be reintroduced to riparian corridors.

PILOT IDEA 4: SWALES ON CONTOUR

HYPOTHESIS: With minor, hand dug earthworks, we will be able to capture and store water to 1) slow and then capture the runoff of water across residential and agricultural landscapes and 2) achieve better growth rates via the provision of water storage in the soil.

Swales are a means of firstly capturing water and slowing down runoff. The volume of heavy rain events distributed over the residential and agricultural catchment can quickly accumulate and contribute to erosion in and around streams as well as increasingly common and problematic flooding in Muri. The fast moving water in heavy rain events more commonly carries a load high in nutrients and fine sediments, like precious organic matter. Incorporated into the soil, organic matter is an essential ingredient and one of if not the best indicators of overall soil health. But fine sediments and organic matter wreak havoc on marine life once introduced into the lagoon. We want to slow water down in general with a special focus on encouraging water to penetrate deep into the soil. Slowing water down also decreases flooding volumes and limits destructive and erosive velocities of stream flow.

By digging a level trench on contour, mounding the excavated soil downhill and subsequently planting trees and over-vigorous rooting plants, we will be delaying a large quantity of water from entering into the stream alongside the rest of the quickly running off water. Swales could be a valuable tool to retain and distribute rainfall higher in the catchments.

Although this pilot has not been a priority as of yet, we still have a similar plan to the initial proposal: Comparing tree growth rate on a single swale 25 meters long to 25 meters of unswaled control but also on contour. In addition to measuring and comparing changes in diameter and size of trees accompanying hand-dug swales, we also have the capacity to measure relative soil moisture to see if we are in fact storing water in the soil.

One of our consultants is also interested in implementing a similar idea of capturing sediment lost from plowed farmland in strategically-located sediment traps. Engaging with local growers and livestock managers will be an essential link in creating future pilots that incorporate productive landscapes. We are also thinking about diverting erosive flows currently concentrated on the roads into roadside swales that settle sediment and reduce downstream damage to roads and downstream sedimentation.

1.3 **LOGFRAME - PROJECT OBJECTIVES, EXPECTED RESULTS, ACTIVITIES, AND INDICATORS**

The Riparian Restoration Pilots aim to build consensus around local best practice stream restoration. In the first year, we will develop the pilot program alongside landowners, schools and interested community members. We will aim to:

- Collect seeds of native plant species to experiment with them in a nursery and riparian revegetation setting. Hopefully we will nursery produce and then plant 2,000 native plants from at least 5 species before the end of 2023.

- Learn more about local hydrology testing small scale water retention and detention schemes. We will aim to get preliminary results from 4 test plots testing the merits of swales on contour.

- We will also aim to build an education program that allows for certificates and rewards for long-term participants.

- By the end of 2023, we will also have high digital engagement from a local community that is well informed of our Pilots and their goals.

This update has three main sections:

1) The latest from our ecological restoration nursery that supplies plants to our riparian restoration trials.

2) Updates on progress of our our experimental planting site and the riparian restoration trials
3) Plans for the future in addition to those already mentioned in the previous application.

NURSERY UPDATE

The nursery now has two small shadehouses, a potting area and an education space. We have also created the framework for a beautiful garden exhibition space that also doubles as a collection of nursery stock plants. We are incrementally adding species to our collection as well as overall production. We plan on adding another shadehouse as well as improving and expanding our standing areas. We are now able to supply all of the plants for our riparian restoration trials.

This year we will upgrade our soil mix from the native soil at the nursery to more targeted, designed mixtures from a clay soils mix, coastal soils mix, seed raising mix, cuttings mix.

We are still developing a suite of pioneer species used for early-stage/post-disturbance revegetation for evaluation on a site-by-site basis.We will continue to improve nursery efficiency and methodologies around each species' needs as well as develop improved systems for the upscaling of production.

The following labeled plant lists are descriptive of the species present at the nursery. We will continue to aim to increase the diversity and utility of the species we focus on.

SUCCESSFULLY COLLECTED OR GERMINATED AND IN GOOD NUMBERS

COMMON	*Genus species*	Food	Flowers/ Aesthetic	Material	Medicine	Native	Family, characteristics and important details
TAMANU POLYNESIAN MAHOGANY	Calophyllum inophyllum		X		X	X	Calophyllaceae, multiple uses of seed oil including anti-ageing and biodiesel. Most mentioned in interviews as a desired species
NEINEI RAROTONGA FITCHIA	Fitchia speciosa		X			X	
PŌʻUTUKAVA SILVERBUSH	Sophora tomentosa		/			X	
TĪ	*Cordyline fruticosa*	X			X		

	VENEVENE SEA GRAPE	*Coccoloba uvifera*	X	/		X		
	MIRO PACIFIC ROSEWOOD	Thespesia populnea		X			X	Malvaceae
	TOU BEACH CORDIA	Cordia subcordata		X	X	X	X	
	PĀTAI FLAME TREE	*Delonix regia*	/	X		/		
	MAUKU A'I VETIVER	*Chrysopogon zizanioides*			X	X		Poaceae, used extensively as erosion control, slows water flow and increases water infiltration
	UMBRELLA PLANT	*Cyperus involucratus*			X			Cyperaceae, culms and leaves usedto make mats, baskets, fans
	MAUKU TAUTA-TAI JAVA SEDGE	*Cyperus javanicus*			X	X	X	Cyperaceae, good for rope and filters - usually present in salty/brackish locations
	KOKA	*Bischofia javanica*	X		X	X	X	Euphorbiaceae. Trees respond well to coppicing and pollarding
	MATA KŌVIRIVIRI RED-BEAD TREE	*Adenanthera pavonina*	X	X		X		Nitrogen fixer, quick to give shade, potentially out-of control invasive given the opportunity
	TAETAPU DADAP	*Erythrina subumbrans*	/	X	X	X		Nurse species, foliage highly nutrient dense and mulches very well
	SILKY JACKBEAN	*Canavalia sericea*	/	/			X	Good in sites where surface sand binding is useful
	KĀKĀ BEACH MORNING GLORY	*Ipomoea pes-caprae*		/			X	
2	**'ARA**	*Pandanus spp.*						Two species, need to ID
	TITI TAI BEACH SUNFLOWER	*Wollastonia biflora*					X	

SUCCESSFULLY ACQUIRED BUT STILL REQUIRE MORE WORK TO SUPPLY RESTORATION PLANTING

	COMMON	*Genus species*	Food	Flowers/ Aesthetic	Material	Medicine	Native	Family, characteristics and important details
	I'I POLYNESIAN CHESTNUT	*Inocarpus fagifer*	X		X	/		Fabaceae

KAVAKAVA (Rarotonga) COOK ISLANDS PITTOSPORUM	*Pittosporum rarotongense*				X	X	different to Kava (Piper methysticum) Found in abundance in mountains
PUKA LANTERN TREE	*Hernandia nymphaeifolia*		/	/	/	X	
'ĀNA'E KING FERN	*Angiopteris evecta*				/	X	Marattiaceae, normally in deep shade
KAVA	*Piper methysticum*	X			X		
MAIRE RĀKAU ALYXIA	*Alyxia stellata*		X	X		X	Apocynaceae, very fragrant and desired ei material
RARA	*Vitex trifolia var. trifolia*			/	X	X	Lamiaceae, many medicinal applications, good erosion control
PUA PUA KENIKENI	*Fagraea berteroana*		X	X	X	X	Loganiaceae
TA'URI'AU MUSKMALLOW	*Abelmoschus moschatus*	/		X	X		
TUITUI CANDLENUT	*Aleurites moluccanus*	X	X	X	X	/	Euphorbiaceae, coppice while young and pollard when old
TOROMIRO	*Schleinitzia insularum*					X	Mimosaceae, leguminous
MATO C.I. HOMALIUM	*Homalium acuminatum*			X		X	Flacourtiaceae, dominant in mountain forest, timber

Part of starting the island's first native nursery has been trial and error.

The following species are proving to be difficult to bring into production. We will continue to try new ways to work with new species. Overall our rate of successfully acquiring new species is high.

UNSUCCESSFUL INTRODUCTIONS TO NURSERY

COMMON	*Genus species*	Food	Flowers/ Aesthetic	Material	Medicine	Native	Family, characteristics and important details
TAU'UNU HELIOTROPE TREE	*Heliotropium arboreum* (FKA *Tournefortia argentea)*	X		X	X	X	common coastal plant [RR], can grow on poor and thin soil, edible leaves, leaves are great mulch
ORONGĀ NATIVE MULBERRY	*Pipturus argenteus*	X		X	X	X	Urticaceae. Fast growing, many medicinal uses internationally
TOATOA WATERCRESS	*Rorippa nasturtium-aquatica*	X					Brassicaceae
MADRE DE CACAO	*Gliricidia sepium*	/	/	X	/		Fixes nitrogen, tolerates low soil fertility, livestock

								fodder, very easy to establish from cutting
	MĀTIRA CYCLOPHYLLUM	*Cyclophyllum barbatum*			**X**		**X**	Rubiaceae, timber

- At the end of 2022, we had on average 5-8 volunteers every Wednesday working bees at the nursery. We also averaged 3-5 volunteers for our stream planting days every Thursday. We also led or co-led in 6 educational workshop days (including over 100 students) in streams, coastal and wetland areas particular to Muri, and have increasingly incorporated educational experiences amongst the weekly working bee activities. A significant portion of our efforts and funding will aim to not only increase the efficiency of the nursery but continue to design our spaces and events with the well-being and enjoyment of our visitors/volunteers in mind.

We have also started giving food to our guests that was grown at the nursery as a means to broaden the appeal of our working bees as well as to promote local growing and eating. One of our goals is to be able to put on morning tea and a lunch dish made with ingredients grown at the nursery exhibition gardens. We also want to cater our species selections to landowners that are more interested in using appropriate sections of riparian corridor for food or animal forage production.

	COMMON	*Genus species*	**Food**	**Flowers/ Aesthetic**	**Material**	**Medicine**	**Native**	Family, characteristics and important details
	RĒMUNA POMEGRANATE	*Punica granatum*	**X**					
	VENEVENE SURINAME CHERRY	*Eugenia uniflora*	**X**					
	PIGEON PEA	*Cajanus cajan*	**X**			**X**		
	KURU BREADFRUIT	*Artocarpus atilis*	**X**	**/**	**X**	**X**	**/**	
	KURU PAPA'A JACKFRUIT	*Artocarpus heterophyllus*	**X**					
	TŌ SUGARCANE	*Saccharum spp.*	**X**		**X**	**X**		Poaceae
	MORINGA	*Moringa oleifera*	**X**			**X**		Medicinal as well as animal forage
	LEMONGRASS	*Cymbopogon citratus*	X			X		Poaceae

We also secured a separate SIF grant with the more expressed purpose of improving guest/visitor/volunteer infrastructure. The main project for that grant will be purchasing and retrofitting a shipping container into an educational workshop space and a high value tool storage.

PARENGARU STREAM: RIPARIAN RESTORATION TRIALS UPDATE

Survey and document the current state of Muri and neighbouring village streams. This includes vegetation, invertebrate species surveys along streams. Also develop low-impact, low-cost solutions to problems we identify.

Described in our "PILOT IDEA 1: ECOSYSTEM ENGINEER TRIALS", the methods for planting at our test site has mostly consisted of establishing a lattice or ladder of Vetiver (*Chrysopogon zizanioides)* hedgerows. We believe this method to be the quickest and most efficient way to stabilize the streambanks of our site that have shown significant bank erosion. We also have, inspired by advice from a Ministry of Marine Resources (MMR) consultant, innovated upon the international common grid practice by planting directly across the stream. We believe these streambed vetiver hedgerows already act as physical barriers filtering the streamwater by slowing flows and catching debris but also by potentially uptaking nutrients in the water or deposited by the water.

We have plans to work with a government agency to track nitrate, temperature and organics before and after the riparian restoration site in order to add to our data on the effectiveness of our actions.

External factors that could affect our goals is access to stream-adjacent land, which we have already spent considerable effort engaging and informing landowners, many of which are already part of the MEC group. We are very careful to be as positive and inclusive as possible.

We have now established the vast majority of the stream bank at the 120-meter section of the Parengaru stream that serves as our riparian restoration trial area. We have continued collaborating with MMR in achieving self-sufficiency in Vetiver supply as well as planting out the lattice/grid pattern stabilizing Parengaru stream.

Now that stage one of our ecosystem engineering trial is complete, we will largely shift focus to the other pilots while also enriching previous plantings to improve their ecosystem services. Observation-focused restoration will be a major part of our next step. We have started a native plants trial plot, but will need to innovate more in their protection to ensure maximum survival and growth. We have recently purchased a brush cutter/string trimmer that will drastically improve our ability to prepare planting sites without herbicide use. We also plan on purchasing wood chips for the non-water exposed tops of streambanks and mulching to limit weed competition which has been one of our greatest challenges.

MEC SMALL GRANT PROGRAM INTERIM FINANCIAL REPORTING

We are pleased to confirm that the total project grant approved is USD50,000 and MEC financial expenditure to 31st January 2023 is USD12,510. The project and the budget will be acquitted and reported within the agreed project timeframe of 30th September 2023.

GEF SGP 2022-23 BIODIVERSITY PROJECT FINDINGS THAT WILL FORM THE BASIS OF OUR JUNE 2023 APPLICATION FOR A SECOND ROUND 2024 GEF BIODIVERSITY PROJECT

- **Improving the efficiency and survival and growth rates of our restoration plantings.**

Growing and supplying our own woodchip. We will require a small wood chipper to process fast growing.

- **Ensuring appropriate supply of root trainers, components for soil mix, - (sand, compost and soil)**

Preparing our own supply of root trainers & components for soil mix.

- **Improving visitor/volunteer experiences even further**

Addressing the resources required and delivering these via grant funds to mobilise these visitor and volunteer resources

- **Bringing Coastal Species and coastal restoration sites into the fold**

For the next round, we would like to expand our focus in incorporating the mouths of the streams and adjacent coasts into our ecological restoration goals.

- **Pa Enua plant translocations**

Given the species National Environment Service and Traditional leaders of all areas involved, there are species not present on Rarotonga that likely once were present before significant coastal development. Over time, we hope to use the nursery to grow threatened and even endangered species for outplanting.

- **Ecological effects of mammalian predators and ungulates**

Mammalian predators have wreaked havoc on Pacific Islands, and the Cook Islands is no exception. Success in increasing Kakerori (*Pomarea dimidiata*) numbers have coincided with continued rat control in the Takitumu Conservation area. Our local success story combined with the numerous successes of the predator-free islands and mainland islands especially in New Zealand, it is a fair bet that efforts to limit mammalian influences in new locations will contribute to more favorable conditions for further native species successes.

- **Mammal exclusion & predator control**

Muri Environment Care is interested in mammal exclusion and predator control in conjunction with the biodiversity corridor goals of our riparian restoration efforts. Our riparian plantings have struggled due to stray livestock as wild chickens - we would be interested in planting inside fencing to determine how much of a factor livestock and wild animals are having on restoration plantings. We also will place a number of rat traps to start monitoring and developing methodology for achieving predator free riparian habitat.

- **Predator Free Projects**

MEC will include predator free deliverables in our future GEF SGF Environmental Ecology projects. Local businessman and philanthropist, John Dunn, has initiated a trial with GoodNature A24 traps. These are self-clearing, self-resetting automatic rat/mouse traps. So far it appears that Rarotongan rats have different lure preferences. Run experiments to determine the lure preferences for rats to help set groundwork for future predator-free projects in the Cook Islands.