TE MATO VAI CYCLIC WETLAND / INTRODUCTION

To prevent the degradation of natural waterways, CSO Te Vai Ora Maori proposes that phytoremediation wetlands are constructed to contain and treat the residuals that are currently discharged from the Te Mato Vai water treatment sites.

The GEF 7 project proposes the Avatiu, Takuvaine, Turangi and Avana valleys in Rarotonga as sites to safeguard ecosystem services and biodiversity. These valleys are also where recently completed Te Mato Vai (TMV) water treatment facilities (WTFs) are located.

Any plan to protect, maintain, or enhance ecological values in the catchment valleys must also seek to mitigate the risks associated with the operation of the water infrastructure.

PROBLEM: DISCHARGE TO NATURAL WATERWAYS

> *Bodies of freshwater in the Cook Islands are extremely limited, with no large lakes or rivers, only wetlands, streams and a few small freshwater lakes present. Freshwater biodiversity is therefore extremely limited. The* Cook Islands National Biodiversity Strategy and Action Plan *lists only nine native and four introduced fish species, two native and three introduced gastropods, and six native and one introduced crustacean.* - Cook Islands 4th National Report to the Convention on Biological Diversity. *NES 2011.*

Operation of the Te Mato Vai system commenced late 2020, and includes the onsite stockpiling of chemical-sediment residues (*sludge*); and the operational discharge of chemically-treated water to the adjacent freshwater streams.

Communicating with the water intake landowners, the TMV Project Management Unit advised: *"…for discharges of PACl (or dissolved aluminium) to the environment..., there is no 'standard' practice"* (GHD Nov 2019). There is no long-term data on the environmental impact of this method of operation, **in New Zealand and Australia, such residuals are not discharged to freshwater ecosystems**, they are cycled back into the treatment path. Aquatic species are highly-sensitive to chemical, nutrient, and particulate contaminants. If environmental discharge is practiced, it is to ground — and not to a natural waterway.

Most of the **treatment facilities are located on sloping land and include 2-3 residual storage ponds, and five formal stream discharge points.** The same streams then flow through residential and recreational areas; provide traditional foods and medicine; irrigate agriculture; sustain wetlands; and ultimately discharge into a lagoon that is a focus for tourism activities. Impacts on biodiversity have already been attributed to the Te Mato Vai Project. **The composition, force, and frequency of discharge all risk impacts of biodiversity**: species, population size, behaviours, distribution, reproduction, and migration.

The non-standard method of operation; the limited freshwater biodiversity; lack of published data on the stream communities; along with uncertainty regarding the long-term impacts make prudent a proactive and precautionary management approach. GEF 7 is an opportunity to take *"active measures to prevent serious or irreversible environmental damage or degradation"* (*Precautionary Principle*, in Cook Islands National Water Policy 2016).

NGATOE WATER TREATMENT FACILITY

A typical Te Mato Vai drinking water treatment site has five formal stream discharge points.

Treatment flow is right-to-left.

INTERVENTION: PHYTOREMEDIATION 'WETLAND' — A LIVING BUFFER

Residual storage ponds can be optimised to process residual water more effectively, making stream discharge unnecessary. Converting ponds to phytoremediation 'wetlands'[1] and modifying operational process will reduce risks to biodiversity; cleaning cycles will be reduced, and the infrastructure will be protected against storm damage.

Phytoremediation uses the growth characteristics of specific plant species to contain or process contaminants in soil or water.

- Vetiver (*Chrysopogon zizanioides*) is a **non-invasive**[2], tropical grass. Internationally, Vetiver Systems have been used to address development challenges including slope stabilisation, septic treatment, dumpsite leachate, and process industrial-agricultural effluent.
- Aluminium phytotoxicity affects plant root function. Most plants are impacted at levels less than 30%; but **vetiver withstands aluminium saturation** of 68%—80%.
- Vetiver is able to grow in diverse conditions and **cycling between dry and wet conditions optimises plant growth**.
- **No native plant species are suitable**. Plants adapted to wetland environments are those of the *Phragmites* family. An introduced reed (*Arundo donax*) is invasive and risks competition with native species; umbrella plant (*Cyperaceae*) is also an invasive sedge and may not be capable of breaking dried sludge or penetrating compacted soil.

Densely planting vetiver around the pond perimeter, and along the maximum storage line will have multiple benefits:

- The grass acts as a barrier to livestock, biodiversity, and people.
- Surface/floodwater is prevented from washing-out the pond: the rigid base of the grass increases the effective height of the pond embankments by half a meter.
- The root system strengthens the sides of the pond: acting as living reinforcing rod.
- Leaves increase the effective pond surface area: plant evapotranspiration increases water processing.
- Water and nutrient from residues is used in leaf and root growth.
- The continual cycle of root growth and decay prevents the compaction of soil, at first improving, and then sustaining pond drainage rates[3].
- Roots adsorb and contain contaminants such as aluminium, preventing such compounds from leaching into groundwater.

Establishing vetiver wetlands will provides a living buffer that effectively negotiates the shared used of the catchment areas, enabling responsible resource use while safeguarding biodiversity and ecosystem services.

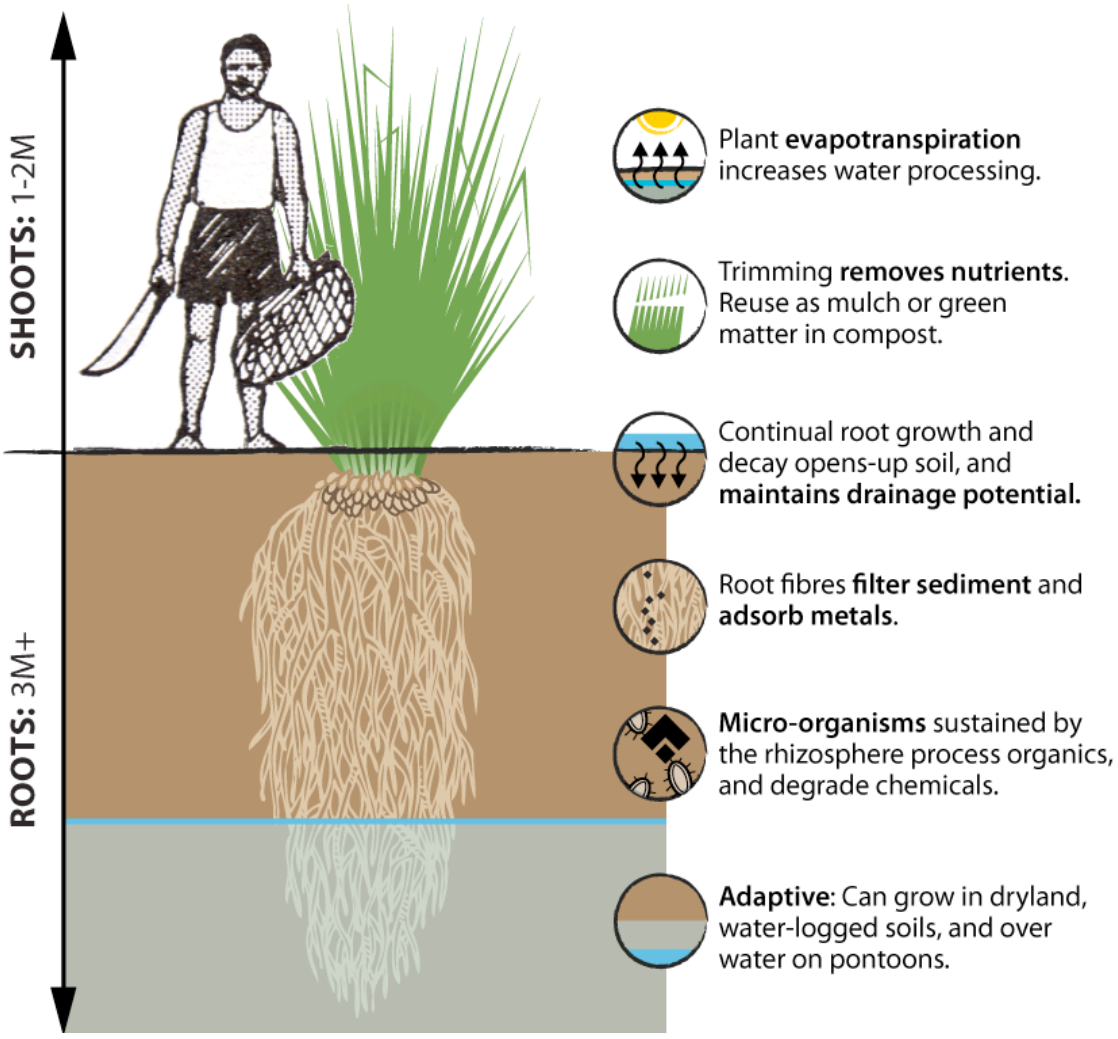
[1] Although termed a 'wetland', operational processes (i.e. sludge removal) are prioritised by the planting design. The project is not proposed to provide habitat for biodiversity.
[2] The vetiver cultivar used for phytoremediation is effectively sterile. It produces no viable seed, and does not spread by runner or rhizome. The grass can only be propagated by splitting a parent plant.
[3] Settled solids form the compound *gibbsite*; gradually sealing surfaces and increasing the risk of overflow.

Turangi combined scour/backwash ponds

The ponds have been constructed alongside the stream bank — indicated by white pole, mid-left of the frame. To clear the pond, surface water is first drained to the stream by lowering the decanting heads. Aquatic biodiversity is highly-sensitive to chemical, nutrient, and particulate contaminants.

Vetiver phytoremediation wetland

The grass will be planted in a double line: around the perimeter of the pond; and across the maximum storage line. Plant growth is enhanced by cyclic flooding-and-drying, which characterises the operation of the Te Mato Vai water treatment system. *Photo: Veticon Consulting, Australia.*



Vetiver phytoremediation