

RESPONSE TO WATER TREATMENT PLANTS: ON-SITE DISCHARGES EIA

This Environmental Impact Assessment (EIA) considers the potential environmental impacts of the activity of using PACl as a coagulant during the operation of the WTPs. Specifically, **the focus of this EIA is on the on-site management of residual materials from the settling tank and sand filter including discharges to the adjacent streams.** Off-site disposal of sludge will be covered in a separate EIA. **This EIA does not consider impacts arising from disinfection of water** (by chlorination or other means).

- *Water Treatment Plants: On-site Discharges EIA*. Tonkin+Taylor 2021

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OBJECTION TO STREAM DISCHARGE

On behalf of 1433 residents of Rarotonga¹, **Te Vai Ora Maori (TVOM) objects to the stream discharge of residuals from the Te Mato Vai water treatment system.**

The Rarotonga Environment Authority should refuse to permit the stream discharge of residuals due to:

- statutory constraints;
- uncertainty regarding the long-term impacts on freshwater ecology;
- that alternative disposal methods have not been adequately investigated; and
- out of respect for cultural values.

To Tatou Vai must be directed to implement improvements to operational process, or Cook Islands Investment Corporation directed to make improvement to the Te Mato Vai infrastructure to ensure that stream discharge is not required.

¹ Signatories to the public petition *Anti-chemical treatment of the water supply of Rarotonga* (2020).

STREAM DISCHARGE

1. The Rarotonga Environment Authority cannot authorise unlawful activity.

Material including sludge or other by products from water treatment plants is **Hazardous waste**.

S.54(2)(d):

“...prohibits **hazardous waste** to be directly or indirectly deposited or discharged, or to seep, into a **waterway**”.

- *Public Health Act 2004* (emphasis added)

Supernatant is a *by product of water treatment*; the *adjacent streams* where supernatant is to be discharged are *waterways*. **The stream discharge of residuals is unlawful.**

2. Cook Islands National Water Policy 2016 directs that infrastructure and development should avoid degrading freshwater ecology.

Precautionary Principle

Taking active measure to prevent serious or irreversible environmental damage or degradation whether the consequences are uncertain or not.

Sustainability & Environmental preservation

Strive to protect and avoid adverse interference with the natural ecology of the Cook Islands’ waters and lagoons, and ensure that usage and management of water will be conducted in a manner that will preserve and enhance this resource for generations to come.

Mitigation of the impact of Infrastructure and Development on Ecological Flows

In designing and delivering future water supplies, infrastructure, services and operations will be provided in a manner that ensures that ecological flows are maintained in natural streams and waterways to the greatest extent practicable in order to ensure the protection of freshwater and coastal ecosystems.

Stream discharge goes against these principles: the impacts of this method of operation are *uncertain*; discharge *interferes with natural ecology*; and *freshwater ecological flows will be disrupted*.

Safeguarding environmental values does not compromise the ability to achieve the benefits of a more reliable water supply system; or the companion Sustainable Development Goals.

As a matter of principle, alternatives to stream discharge should be investigated and implemented.

3. Stream discharge of supernatant is not ‘standard practice’. Operating the new system using an un-researched method risks the long-term health of stream communities.

5 Monitoring and Management Practices (Environment)

62. In New Zealand and Australia, in most cases sludge supernatant is recycled back to the inlet of the water treatment plant.... Only the sludge becomes waste product as the supernatant is recycled....So, **for discharges of PACl (or dissolved aluminium) to the environment (through supernatant), there is no ‘standard’ practice.**

- GHD Nov 2019 (emphasis added)

The full reference details that a single water treatment plant (WTP) practices stream discharge: the Frasertown WTP, Wairoa, New Zealand².

- Stream discharge goes against standard industry practice. In the whole of New Zealand and Australia, GHD advise that Frasertown is the *only* drinking-water WTP that discharges residuals to the stream.
- GHD — and now Tonkin+Taylor — have duplicated the Frasertown monitoring regime: measuring the aluminium levels in streamwater.
- The Frasertown resource consent was issued under New Zealand *regulatory framework* and subject to the provisions of the New Zealand *Resource Management Act*. For example, resource consents are issued for a fixed period/subject to renewal.
- The Frasertown discharge to water resource consent is *location-specific*. It is issued specific to a consideration of climatic conditions, temperature, river flows, biodiversity, etc.

Replicating the Frasertown aluminium monitoring regime is not sufficient precaution against long-term impact. The Frasertown monitoring regime was not established to research the impacts of stream discharge on biodiversity. To do so would require the collection of baseline data and sustained biophysical monitoring of changes to aquatic habitats, flora or fauna.

Additional steps must be taken to safeguard Rarotonga’s freshwater ecosystems, foremost being investigation and implementation of alternatives to stream discharge.

² Discharge permit DP110406W – expires 31 May 2022.

4. The *Te Mato Vai Project Aquatic Ecology Baseline Report (GHD Nov 2020)* summarises the risk of stream discharge as: *low and acceptable*. However this must be countered by the caution that there is **minimal published research on Rarotonga's stream communities** and that the **long-term ecological impacts of stream discharge have not been researched**.

Risk of ecological impact resulting from supernatant discharge (low-high) reuse (low risk) —> ground discharge (med. risk) —> stream discharge (high risk).

Of the seven **environmental incidents** reported to TVOM, five coincided with the intentional or accidental discharge of commissioning residuals to the stream.

As noted in the applicable technical standard:

...[residual] water shall be drained and flushed away to a suitable outlet where no harm will result from the flow or its contents.³

It is not only residual (chemical or physical) *contents*, but also the *force* and *frequency of flow* that risks harm.

5. Supernatant discharge affects stream **chemistry, biology, and sediment** (distribution and composition).

To date, monitoring has been of **water chemistry values** against regulatory *trigger* and *guideline values*: the levels of aluminium in streamwater above and below the discharge point. Samples were not collected at the **settling tank mid-level drain**, or the **surface of the sludge ponds** where chemical concentration will be highest⁴.

Streamhealth will be impacted by changes in stream sediment: composition and distribution.

- **Biodiversity avoidance behaviours** due to disruption of ecological flows may impact **species distribution, migration, population size, and reproduction**. Koura are a keystone species. They eat invertebrates such as insects and worms, breakdown leaf litter, and cycle nutrients. The health of koura populations affects the health of our streams.
- **Periodic / irregular discharge** can “possibly disrupt stable ecosystems more than a continuous low-level discharge.” (Umgeni Water 2017)
- An **increase in sediment** can result in **benthic smothering**. Fine particles can **reduce the light to streambed plant communities**. (Umgeni Water 2017)
- **Aluminium has been found to bioaccumulate in the tissue of freshwater species** including *kōura* and common *bully* (fish). Short-term observation proposes the effect to be non-toxic, but **chronic impacts are unknown/un-researched**. (Tempero 2015)

³ *Infrastructure Cook Islands Technical Standards for Water Supply in Partnership with the Institution of Professional Engineers Cook Islands, 30 May 2014.*

⁴ These additional samples points are proposed in Appendix F of the T+T EIA report.

6. **Further research is required** to identify and evaluate the feasibility of:

a) **Changes that can be made to operational process** — using the current treatment method — **to prevent the need for stream discharge.**

For example, **draining and clearing the settling tank over an extended period of time.**

This would allow supernatant removed from the settling tank to drain to ground (through the pond) before operators proceed to clear sludge.

More frequent removal of of sludge for offsite disposal will also improve storage pond drainage.

b) **Modification to the Te Mato Vai infrastructure to optimise pond discharge.**

One such option is to enhance operation by converting the storage ponds to cyclic vegetated treatment wetlands. This will improve drainage, increase water processing, and contain contaminants. This modification would be of benefit even when operational process is changed.

See appended concept note: Te Mato Vai Cyclic Wetland.

7. **The EIA does not sufficiently detail operational activities.**

a) **How often will residuals be discharged to the stream?**

From the settling tank and from each type of pond.

b) **What is the anticipated volume of residual that will be discharged?**

The volume firstly drained to the sludge pond, and then decanted from-pond-to-stream.

This information is necessary for evaluating the permit application; and also to determine the feasibility of alternative residual disposal methods.

Information on operational activities was requested from the Te Mato Vai Project Management Unit/GHD, but not provided prior to the filing of this submission.

8. Stream discharge is culturally-inappropriate.

In public meetings, by way of two public petitions⁵, and through policies and legislation, the people of the Cook Islands have committed to acting as custodians of the island environment.

Rarotonga's freshwater streams are used as a food basket, as a source for preparing natural medicines, provide materials for handcrafts, and provide family recreation. The streams sustain wetland areas and flow into the lagoon. Disruption of ecology at the level of the discharge points has the potential to impact on downstream use and enjoyment of this shared natural environment.

As noted by NES compliance manager Vavia Tangatataia:

Over and above the biophysical impacts, there is a concern around putting contaminants into water — fullstop.⁶

It is irresponsible to rely on reassurances from offshore consultants, derived largely from desktop analysis when operation risks the majority of Rarotonga's freshwater ecosystems; along with the cultural practices bound to these environments. More appropriate is to modify the treatment system to avoid action that is culturally inappropriate.

9. Due to the statutory constraints, the uncertainty regarding the long-term impacts on freshwater ecology, that alternative disposal methods have not been adequately investigated, and out of respect for cultural values, **the Rarotonga Environment Authority should refuse to allow the stream discharge of residuals.**

⁵ The *Te Mato Vai Project Petition* (2014); *Anti-chemical treatment of the water supply of Rarotonga* (2020).

⁶ [T+T] *Discussion with National Environment Service (NES)*, Friday 17 January 2020. (Appendix to the On-site Discharge EIA Report.)

EVALUATION OF ALTERNATIVES

The Te Mato Vai treatment system is anticipated to serve the island for the next 100 years. Alternative treatment methods must be sufficiently detailed to allow meaningful comparison.

Inherent to the EIA process is to ‘consider likely/potential impacts **before** an activity takes place’⁷.

With the Te Mato Vai Project evaluation of the treatment method comes after the system has already been constructed, and after nine months of operation. This may have compromised the investigation of alternative methods and processes.

Beyond direct comparison of coagulant chemicals in terms of raw water quality, relative expense, and relative waste volumes, the method of assessment lacks integrity, as determinants include:

- whether the required infrastructure has already been constructed;
- (only) the direct replacement of PACl by the alternative coagulant or treatment method;
- that there is no access to power (the Watson report identifies alternative power sources);
- minimal consideration of alternative residual disposal methods;
- misleading conflation of coagulation with disinfection.

Direct replacement

Diversion systems could *supplement* treatment to optimise the manual-and-fixed PACl dosing system.

The decrease in sludge production will increase the time between cleaning cycles and increase the likelihood that sludge ponds will dry naturally, meaning that that stream discharge will not be required (from the ponds).

⁷ Chris Purchase (T+T); Discussion with representatives from landowners / Te Vai Ora Maori (TVOM), 18 Jan 2020.

PACl + Diversion

It is necessary to evaluate the benefit of *optimising* treatment with diversion systems.

- The T+T EIA suggests that diversion systems could achieve comparable improvements in turbidity (without PACl); if the existing physical filtration steps are supplemented by physical pre-filtration (in the intake weir) and/or 'fine' filtration (post AVG).⁸ These options should be considered in more detail.
- The lack of a permanent power supply is not a deterrent to implementing diversion. Watson detailed an option in his report for solar and battery. Battery-powered systems have already been installed to implement chlorine.
- Full-cost analysis would factor in the costs of reduced chemical supply and/or waste management. Along with minimising risk and waste, diversion systems will reduce the ongoing cost of operation.

Turbidity data from the PACl-trial suggests that **diversion will have minimal impact on water collection (abstraction) rates.**

Of the 1763 raw streamwater samples collected by GHD Sept 2020-May 2021:

- **49% meet UV standard** (under 1.0NTU); and
- **93% met the World Health Organisation turbidity⁹ standard** for lower resource settings/small supplies (under 5.0NTU)¹⁰.

In calculating sludge volumes, Watson factored in a **plant utilisation of 60%**. Overnight, water demand drops and treatment stops once the storage tanks are full. Rain events that occur during periods of already low demand will have less impact on the overall abstraction rate.

A further argument *against* diversion is that it would compromise supply — by not collecting all available water during periods of high rainfall.

In general terms:

- water demand falls in wet weather (less agricultural use, fewer loads of washing);
- directly after rain, the increase in groundwater flows will rapidly recharge stored supply; and
- household and commercial water storage tanks are recharged by rainfall, which reduces network demand.

⁸ A request for collection of data to enable comparison of treatment efficacy with-, and without PACl was made to the PMU by TVOM and landowners in Dec 2020. No response was received.

⁹ Turbidity level prior to disinfection.

¹⁰ *Water Quality and Health — Review of Turbidity: Information for regulators and water suppliers.* 2017. WHO.

Treatment volumes are already constrained: by the sand filter throughput and the size of the storage tanks. More water flowing down the stream does not translate to more water in the tanks.

When the trunk mains from Avana and Turangi were severed in Aug 2020, the (then) To Tatou Vai operations manager was confident that supply could be sustained by the other intakes for up to a week. Island-wide rainfall is rare, as **each valley has its own microclimate**. Turbidity levels peak when rain follows a period of dry weather, but then stabilise (after the ‘first flush’ of surface run-off has been washed downstream). **Streams clear again within three hours of rainfall.**

Rather than speculation, sustained data can be used verify the feasibility of diversion to achieve required turbidity standards and meet required abstraction rates.

PACl is not a disinfectant

PACl is not an effective or reliable method of achieving drinking-water *microbial* standards.

“...although correlations [between turbidity and microbial content] may exist in individual drinking-water supplies, a uniform relationship has not been established.”

- *World Health Organisation 2017*

A reduction in turbidity is not certainty of a reduction in microbial content.

The purpose of the PACl, as a *coagulant* — when combined with the other treatment steps — is to improve water clarity. At best, polyaluminum chloride could be described as a ‘chemical-filter’: as any reduction in microbes is through the settling-out of particles.

Due to the numerous allusions in the EIA report, it is necessary to state that **PACl is not a disinfectant**. The chemical is not used to kill or deactivate microorganisms.

The subject of disinfection is also expressly excluded from the On-site Disposal EIA; which *‘does not consider impacts arising from disinfection of water (by chlorination or other means).’* It is incongruous to make this declaration and then include in the report misleading statements that do not relate to the operational function of the chemical.

ABOUT TE VAI ORA MAORI

Water treatment methods preferred by Te Vai Ora Maori include **diversion, physical filtration**, and processes that result in **zero waste**. The preferred and more reliable method of disinfection is by **UV** irradiation ‘at the tap’. Where the by-product of water treatment cannot be reused, it must be responsibly processed and contained rather than discharged to the environment.

REFERENCES

- *Environment Act 2003*.
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- *Guidelines and Good Practices for Water Treatment Residues Handling, Disposal and Reuse in South Africa*. Dec 2017. Umgeni Water.
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- *Te Mato Vai – Stage 2 – Expert Independent Report*. March 2020. A. Watson, Ministry of Justice.
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- *Water Treatment Plants: On-site Discharges Environmental Impact Assessment*. May 2021. Tonkin+Taylor.

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CONCEPT NOTE: TE MATO VAI CYCLIC WETLAND

The To Tatou Vai EIA: *Water Treatment Plants: On-site Discharges* (prepared by Tonkin+Taylor) seeks a permit from the Rarotonga Environment Authority (REA) to operate the Te Mato Vai water treatment system. The proposed method includes the periodic discharge of chemically-treated drinking-water residuals to Rarotonga's streams.

This concept note proposes that the residual storage ponds can be adapted to become treatment wetlands. Combined with modification to operational process, stream discharge can be avoided.

TVOM has prepared this concept based on knowledge of the treatment process, layout and general climatic conditions at the Papua, Avana, Turangi, Matavera, and Takuvaie Water Treatment Plants (WTPs).

As each valley has a unique microclimate, pond conversion should prioritise the WTPs susceptible to surface flooding, or locations where ponds are unlikely to dry naturally.

- The wetland concept has been reviewed by environmental engineers practised in vetiver system (VS) applications: Peter Pitcher (Northern Territories Environmental Services) and Robinson Vanoh (South Pacific Islands Vetiver Network).
- Don Miller (formerly DSIR-NZ) confirms that vetiver can tolerate high aluminium saturation concentrations – up to 80%.
- Joseph Brider (Cook Islands Biodiversity) has advised on potential native species that could be planted into the sludge ponds to further break-up sludge cake. Plants with ideal characteristics are those of the *Phragmites* family. No suitable native plant species were identified: the one introduced reed (*Arundo donax*) is invasive. *Cyperaceae* (e.g. introduced/invasive Umbrella Plant sedge) grows in wet environments but root system may not be capable of breaking dried sludge.
- Vetiver stocks are available locally from Avana Vetiver.

Information is required on residual volumes and operational processes to confirm feasibility. Dr Paul Truong (Veticon, Australia) could be engaged by TTV/CIG to prepare an assessment and guidance on treatment system design. Dr Truong has pioneered the use of vetiver for water treatment and previously modelled use of vetiver for treatment and as a disposal field crop for the Muri septic reticulation (for GHD).

ENVIRONMENT

As there is no industrial outlet for residual water, and no on-site power to recycle residual back into the settling tank, **To Tatou Vai are proposing to discharge supernatant to the stream(s) adjacent to the WTPs.**



- The configuration of the TMV system is constrained by topography, lack of land, and locations that are subject to high annual rainfall. Locations such as Turangi (above) are partially shaded and sheltered from the prevailing wind, so unlikely to dry naturally.
- The industry practice is to use multiple storage ponds — this allows one pond to be in operational-use, while another is left to naturally dry. At the Te Mato Vai WTPs: the **scour and backwash ponds are in continual use.**
- **Surface flooding** in June and August 2020 lead to the overflow of the main storage pond in Takuvaie. These incidents occurred prior to the operational use of chemicals.
- **Backwashes occur automatically** in response to changes to raw water quality. Operators may not be onsite to stop treatment in the case of potential overflow, or during storm events.

Desktop analysis and data collected as part of the PACI-trial (Sept 2020-May 2021) proposes that the aluminium level in residual by-product after mixing with streamwater is below guideline values that are protective of environmental health. The Te Mato Vai *Aquatic Ecology Baseline Report* describes the risk of impact as *'low and acceptable'*.

However, the non-standard method of operation, the lack of data on Rarotonga stream communities, and uncertainty regarding long-term impacts suggest **a proactive and precautionary approach is prudent to avoid the degradation of freshwater ecology.**

DRINKING-WATER RESIDUALS

'Residual' is a collective term describing the by-product of the water treatment process.

de-chlorinated water: Chemical re-sterilisation of the tanks may be required¹. The commissioning process required the discharge of chlorine solution: de-chlorinated using sodium thiosulphate. *An eco-friendly alternative to chlorine is the spray-application of anolyte solution.*

supernatant: the residual water generated by the treatment process which is directly dosed with polyaluminum chloride (PACl) or exposed to mixing with sludge/sediment containing the coagulation chemical.

sludge: organic material and aluminium precipitate that falls to the bottom of the settling tank. The EIA does not propose that sludge will be discharged to the stream, however sludge may be resuspended: by operational processes; when surface water is decanted; or in flood events. Settled aluminium hydroxide sludge forms the mineral *gibbsite*.

settling tank overflow from the PACl mixing chamber: supernatant is discharged to the stream when treatment stops (when water storage/pressure tanks are full and there is low network demand).

near-clear water: streamwater mixed with PACl is discharged to the stream from the top part of the tank through the **mid-level drain** when sludge is cleared from the settling tank.

scour: sludge-and-supernatant drained from the bottom of the settling tank.

backwash water: the fine organic material and supernatant that is flushed from the sand filters by an automatic cleaning cycle and directed to a storage pond. Backwash timing is determined by raw water quality, i.e. the process is not operator-controlled.

pond supernatant: surface water from the scour and backwash ponds. This water may have a higher level of aluminium due to being in sustained contact with accumulated sludge.

pond washout: unintended discharge of supernatant and suspended sludge.

¹"For normal clearing of sludge, where staff are not required to enter the tank, disinfecting with chlorine would not be required. If personnel entry is required then a varying level of disinfection would be required depending on the amount of contact the staff had with the tank surfaces." (Peter Free, GHD, pers. comm. June 2021)

DISCHARGE POINTS

Typical WTP layout has five formal residual discharge points. There is also the draining/dewatering of pond surface water prior to removal for permanent disposal; and the risk of pond washout due to surface flooding.



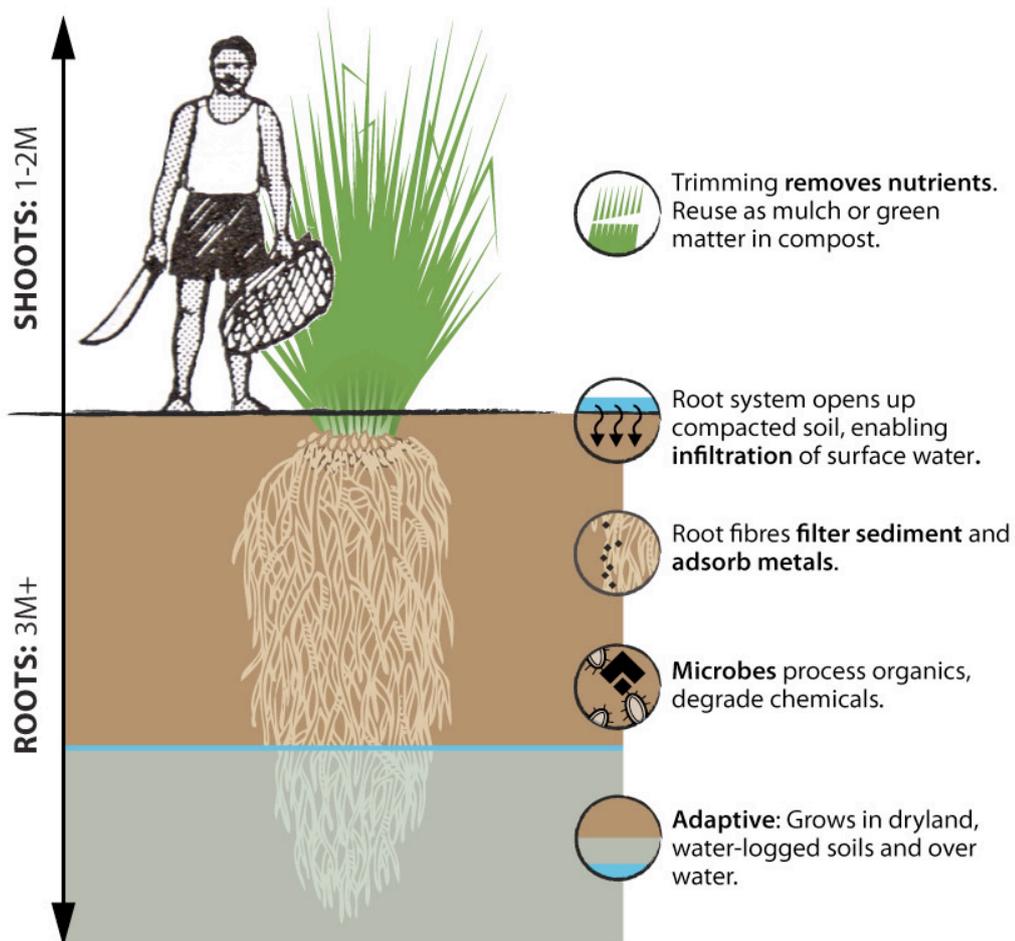
NGATOE WATERWORKS SHOWING STREAM DISCHARGE POINTS
Overflow and wastewater from the treatment process is discharged to the stream at five points.
Treatment flow is right-to-left.

VETIVER SYSTEMS: PHYTOREMEDIATION

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

- Vetiver grass (*Chrysopogon zizanioides*) is a fast-growing, **non-invasive**, tropical grass used in applications including domestic and industrial wastewater treatment.
- The grass is naturally resistant to high levels of aluminium able to withstand saturation threshold of 68%—80%.
- The grass grows in dryland conditions, water-logged soils, and over water on rafts/pontoons.

Vetiver is already grown in Rarotonga and has been proposed by GHD for the land disposal of wastewater as part of the Muri septic reticulation.



VETIVER PHYTOREMEDIATION: WASTEWATER PROCESSING

Sources: *The Vetiver Network International*, tvni.org; *Phytoremediation: Technology Evaluation Report*, JL Schnoor, GWRTAC 1997.

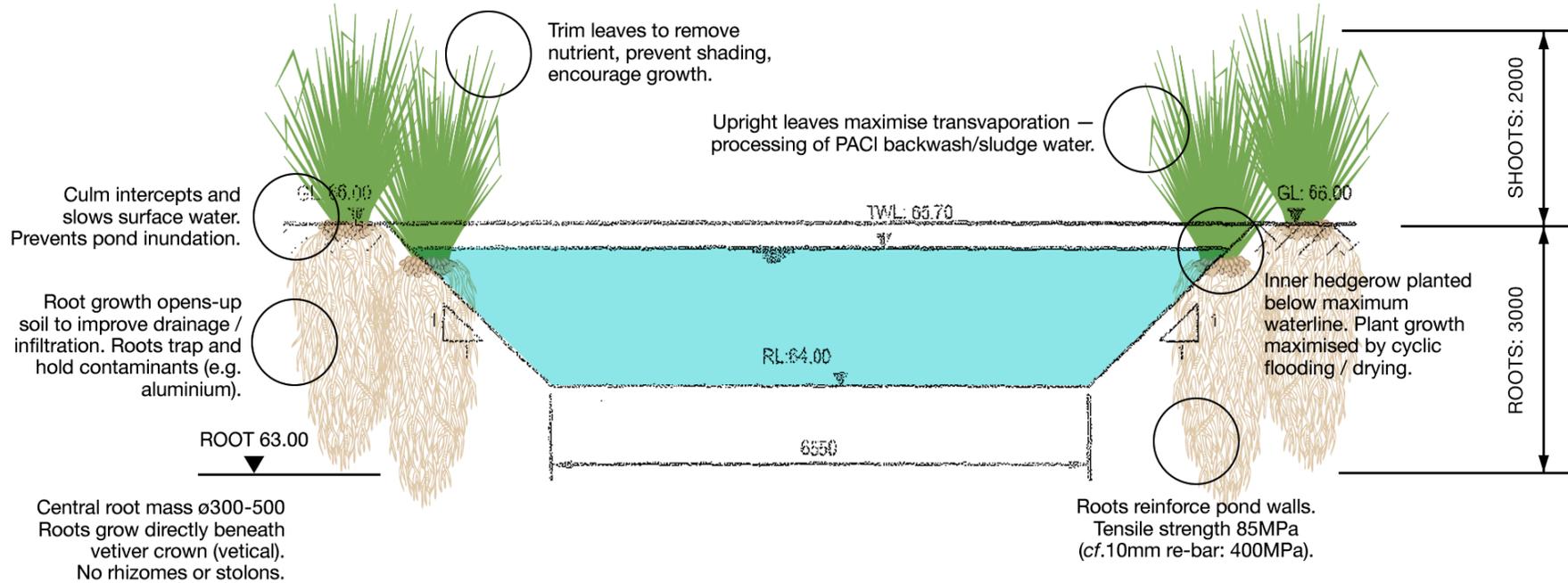
CYCLIC WETLAND

Scour (sludge) and Backwash ponds would be planted as cyclic vetiver wetlands. 'Cyclic' as the **ponds are flooded, and then allowed to dry-out**. This is good fit with operational process and maximises plant growth.

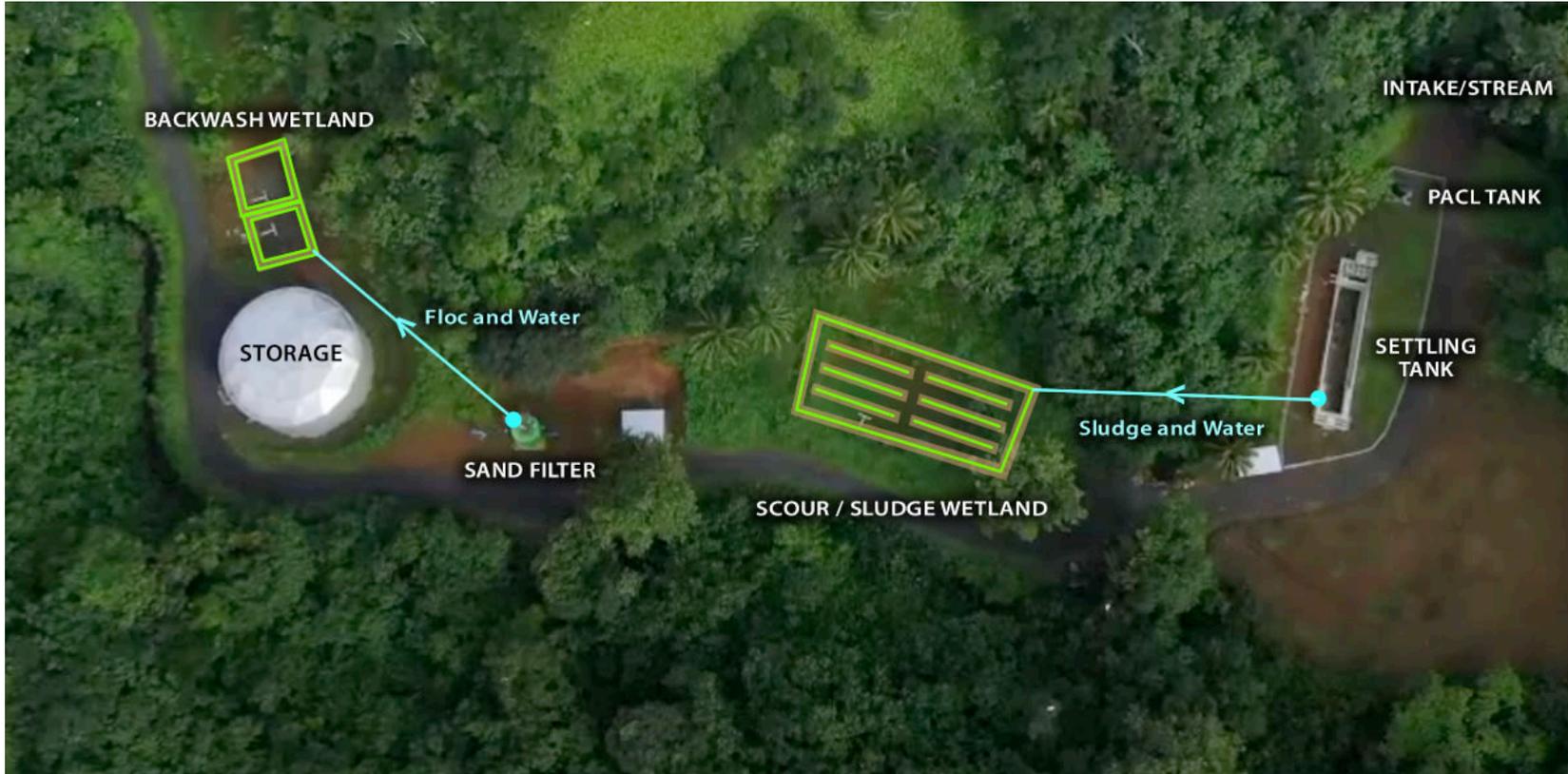


- Vetiver will be planted around the perimeter of the pond (and potentially on raised beds). *Photo: Veticon Consulting (Australia).*
- Residual nutrient and water is used for root and leaf growth. Climatic conditions in Rarotonga are ideal. Leaves grow up to 20cm/week; roots 1-2cm/day.
- Plant evapotranspiration increases the effective 'surface area' of the pond. Water processing will improve.
- The dense and (3m+) deep root system grows directly downward and will stabilise the sides of the pond.
- Root growth opens up soil to increase pond drainage potential (improves infiltration).
- The root system filters out and binds minerals, including aluminium. Microbes living in the soil further purify the water.
- Vetiver has been used in the treatment of wastewater/tailings in aluminium (bauxite) mining. The grass has an aluminium saturation threshold of 68%—80%. Most plants are adversely affected by aluminum levels less than 30%.
- Plantings will be spaced to enable easy clearing of residual sediment by excavator and/or suction truck.

A supplementary enhancement is to plant vetiver downslope of the ponds (into the existing rip-rap. **When sludge is removed for permanent disposal**, the supernatant will be drained through the grass. The hedgerow would also minimise impacts of any unplanned overwash due to surface flooding.



CYCLIC WETLAND / TE MATO VAI REMEDIATION CONCEPT
Adapted from: *Section B-B Backwash/Scour Pond.*



NGATOE WATERWORKS VETIVER REMEDIATION CONCEPT

In the remediated treatment process, wastewater will only be discharged to the Scour and Backwash Wetlands (formerly ponds). Constructing cyclic vetiver wetlands avoids the need for stream discharge.

SUPPLEMENTARY REMEDIATION

Water quality standards are achieved by a number of treatment steps. **Reducing the volume of residual or the frequency of cleaning cycles will decrease the need for stream discharge.**

The PACI-trial data indicates that Rarotonga's streamwater is of exceptional clarity.

Of the 1763 raw streamwater samples collected Sept 2020-May 2021:

- **49%** met the UV standard (under 1.0NTU)
- **93%** met the World Health Organisation turbidity² standard for lower resource settings/small supplies (under 5.0NTU)³

Diversion combined with physical filtration is a suitable method to meet water quality standards, and will avoid the need for chemical coagulation.

- **Diversion systems:** Only collecting 'clear' streamwater for treatment will reduce the frequency of cleaning cycles as less sediment enters the settling tank. Turbidity data from the PACI-trial suggests that diversion will have minimal impact on abstraction rates.
- **Physical filtration:** Pre-filtration in the intake weir to strain out surface particles, and 'finer filtration' post-AVG (if necessary).

RESIDUAL VOLUMES/CLEANING CYCLES

The values below are referenced from *Information Pack: Stage 2 Commissioning*. (GHD Nov 2019); correspondence with the Te Mato Vai Project Management Unit; and water technicians. Pond configuration and volumes and are specific to each WTP.

- **near-clear water:** *unknown volume* / cleaning cycle every 6 weeks?
- **sludge+supernatant:** *unknown volume* / cleaning cycle every 4-6 months?
- **backwash:** 15m³ / automatic cycle every 2-3 days? / cleaning cycle unknown.
- **backwash ponds:** 41.6-62.4m³
- **scour ponds:** 120/180m³
- **combined ponds:** 72-120 m³

Pond volumes include 300mm freeboard.

TVOM has requested the detail on the above volumes and operational cycles (e.g. frequency of backwash). GHD has responded that the public will be charged \$1000 for this information.

² Turbidity level prior to disinfection.

³ *Water Quality and Health — Review of Turbidity: Information for regulators and water suppliers*. 2017. WHO.

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