MASTER PROJECT DOCUMENT

Clean Water in Papua New Guinea

A Blueprint for Scalable, Gravity-Fed Water Infrastructure

The Eastern Highlands of Papua New Guinea — steep, fertile mountains where creeks near the ridgelines can supply whole villages by gravity alone.

Korepa Community, Eastern Highlands Province, Papua New Guinea

Prepared for the Clean Water Help technical team and project partners

Consolidated from project summaries, technical design notes, field reports, and team meeting records

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This document is organized so you can stop reading whenever you have what you need. It moves from the big picture to fine technical detail in three layers:

> **The three layers**
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> **Part 1 — Executive Summary & Overview.** The story, the strategy, the numbers, and the people. Read this if you want the whole project in a few minutes.
>
> **Part 2 — The Project in Moderate Detail.** How the system works today, the four-phase plan, the treatment decision, and what the field reports tell us. Read this if you are helping make decisions.
>
> **Part 3 — Full Technical Detail & Reference.** Hydraulics, the per-spigot ultrafiltration protocol, parts lists, the sourcing request, site data, and the meeting record. Read this if you are designing, sourcing, or building.

A note on terminology: *"UF" means ultrafiltration. "PRV" means pressure-reducing valve. "spigot" and "tap" are used interchangeably for the points where people collect water. "K" refers to PNG kina (the local currency; roughly 1 USD ≈ 4–5 kina).*

Part 1 — Executive Summary & Overview

The Opportunity

This project has a problem most humanitarian water projects never get to face: **there is already too much safe water.** In 2024, local leader Philip Wayaki Bongi — working with a supporting NGO and his community — installed a high-efficiency, gravity-fed drinking water system in a region where families had relied on ponds and creeks. For about $15,000 — funded largely by community labor — that system now delivers roughly 10,000 gallons of piped river water per day to about 3,500 people, comfortably more than they need.

The strategy now is to shift from *producing* water to *distributing* it: to extend pipelines from an existing daily surplus to thousands of neighbors less than two miles away who are still drinking contaminated water, and to add low-cost pathogen removal (ultrafiltration or chlorination) so the water is not just cleaner, but genuinely safe. The model delivers safe water at roughly **$5 per person** — about a 10x return compared with the global NGO average.

> **The project in one sentence**
>
> *Take high-quality creek water from the top of the mountain, treat it simply, and carry it downhill by gravity to one village after another — led by the community, supported by volunteer water experts, and built to last for decades.*

Key Project Facts at a Glance

Phase	What it does	People reached	Cost
Phase 1 (Pilot, 2024)	Original system: creek catchment, storage tanks, ~2.2 km pipeline, 9 spigots	~3,500	~$15,000
Phase 2 (Short-term)	Pilot pathogen-removal options, then extend pipeline ~1.5 km to bridge the “two-mile gap”	~1,500–1,600 more	~$5,800–$7,000
Phase 3 (Medium-term)	New system at a mountaintop school; gravity-feed ~7 km pipeline to villages below	~2,700–3,000+	~$14,000
Phase 4 (Vision)	**Scale the proven model region-wide through corporate and grant partnerships**	**Region-wide**	**Partner-funded**

Strategic advantages

- **Community-led labor.** Villagers volunteer to dig trenches, carry materials uphill, and pour concrete — eliminating the largest costs.
- **Low-cost pathogen removal.** Gravity pressure makes ultrafiltration practical without electricity or pumps.
- **Proven local leadership.** A trusted, capable local leader (Philip) bridges the technical, funding, and community sides.
- **A supercharged volunteer model.** The community provides the labor; volunteer water-resource experts provide optimal design and maintenance guidance.

Project Origins: Science vs. the “Invisible Killer”

Community members hand-dig kilometers of trench up steep mountain terrain

— the labor contribution that makes the economics work.

In rural PNG, waterborne illnesses like typhoid are frequently blamed on witchcraft. Because the killer is invisible and deaths can be sudden, fear often takes the place of logic — and innocent people are sometimes accused. Philip Wayaki Bongi, who returned to his village after university, refused to accept this. He recognized that the walk for water was getting longer while outbreaks were getting worse, and he led a community effort to build a distribution system carrying clean river water down the mountain to the people living along the way.

Phase 1 (The Pilot): The First Success

The 2024 pilot was a masterclass in community-led infrastructure. Philip mobilized local leaders and villagers to hand-dig roughly two miles of trench and build a concrete storage tank. By eliminating paid labor and heavy machinery, a project that would typically cost $25,000 and take a year was completed for about $15,000 in under six months.

Years later, the system still reliably serves about 3,500 people and has nearly eliminated typhoid outbreaks in the village. It produces a surplus of roughly 5,000 gallons per day — water sitting in tanks while neighbors less than two miles away continue to fall ill. The remaining gap: while the piped water is far safer than puddles and creeks near the villages, it is **not yet completely pathogen-free**.

Materials carried by hand up the mountain

The community builds the concrete catchment by hand

Phase 2 (Short-Term): Bridging the Two-Mile Gap

Less than two miles from the current system, a community of about 1,600 people still drinks from contaminated forest ponds, making a daily ~1.5-mile trek for the same typhoid-laden water that once plagued Philip’s village. Because the water already exists, no new treatment plant is needed — only distribution.

Phase 2 begins with a pilot to test and optimize the pathogen-removal options — comparing ultrafiltration against chlorine — before extending the system. Once the best solution is chosen, a ~2-mile pipeline extends from the existing surplus tanks, including check/gate valves to manage pressure and protect pipe joints.

Phase 2 at a glance

- **The problem:** contaminated source water and no distribution lines for the next community.
- **The solution:** extend a ~2-mile (1.5 km) pipeline from existing surplus tanks; add valves for pressure management.
- **Total cost:** approximately $5,800.

Phase 3 (Medium-Term): Reaching the Mountaintop School

The next milestone targets a regional hub: a school near the top of the mountain serving about 300 children, with five villages and nearly 2,700 people below it. The plan installs a second primary water system at the school and gravity-feeds a ~7-kilometer pipeline down the mountain road — giving the children immediate safe water while supplying the villages below.

Phase 3 at a glance

- **Scale:** 3,000+ total people reached.
- **Logistics:** similar terrain to the first project.
- **Total cost:** approximately $14,000.

Phase 4 (The Vision): A Scalable Partnership

The experimental phase is over. The combination of community-led leadership and volunteer technical expertise has been shown to produce roughly a 10x return in humanitarian impact. The next step is to scale the model across the region with corporate and grant partners. Papua New Guinea has some of the world's most limited access to clean water; moving safe water directly into these communities doesn't just stop the fever — it gives parents time to work and children the health to stay in school.

> ***"The water is already flowing. We just need the partners to help us carry it to the end of the line."***

Part 2 — The Project in Moderate Detail

Where This Is Happening

The project is in the Korepa community, Eastern Highlands Province, Papua New Guinea — mountainous terrain near Goroka town. The closest town that can receive a shipment is more than 10 miles away over very restricted roads. The map below shows the existing first system (in blue) and the routes of planned expansions (in yellow), along with nearby landmarks such as churches and Joite Elementary School.

Annotated Google Earth view of the project area. Blue marks the existing first system; yellow marks planned expansion routes ("1ST," "NS," and "PD" are field markings). Recorded source elevation near the catchment is about 1,840 m.

A detailed, interactive Google Earth model of the area is maintained by the team. *(Link provided in Part 3, Appendix E.)*

How the System Works Today

Creek water fills a 40,000-liter concrete storage tank (about 2 m × 2 m × 1 m) at the top of the mountain. From there it travels downhill through sealed poly pipe to the villages, with spigots branching off along the way. The first distribution line runs about 2.2 km at roughly a 10-degree decline, dropping around 360 m in elevation — enough to create very high water pressure at the lower end (more on this in Part 3). Smaller storage tanks (a 9,000 L and a ~6,000 L) sit higher up, closer to the catchment, and additional tanks step the water down toward the lower communities.

The concrete catchment tank holds and settles incoming creek water

A "Tuffa" storage tank installed beside a building downstream

The system is entirely passive. There is no electricity at the site, and solar is considered impractical and theft-prone because the tanks sit in uninhabited areas where valuable panels would likely be stolen. Gravity-based designs are therefore strongly preferred. The community maintains the system itself: trained local leaders monitor it, report problems by smartphone, and a community fund (about K20 — roughly USD $4 — per household) pays for repairs.

What the community has already proven it can do

- Hand-dig kilometers of trench up steep terrain, on scheduled workdays.
- Carry cement, bricks, sand, pipe, and tanks uphill by hand (the road ends ~3 km below the site).
- Build concrete catchments and install tanks, taps, and valves with one local plumber.
- Diagnose and fix real problems — e.g., rebuilding after a landslide diverted the source, and fixing a taste issue caused by algae by adding a wire mesh cover and inlet/outlet strainers.
- Self-organize a maintenance fund and assign accountable local leaders.

The Core Technical Question: How to Make the Water Truly Safe

The current water is a major improvement, but the team's central objective now is treatment — removing the pathogens (like the bacteria that cause typhoid and cholera, and protozoan cysts) that piped creek water can still carry. The team evaluated the full menu of options against a hard reality: no reliable electricity, very limited supply chains, one local plumber (no professional engineers on site), landslides, and storm turbidity.

Options considered

Option	Verdict	Why
Source protection (cap a spring / extend intake upstream)	**Pursue first**	Cheapest, most sustainable. Cleaner water at the top reduces the need for any downstream treatment.
Ultrafiltration (UF, 0.01 µm) at each spigot	**Leading option**	Gravity pressure is a big advantage. Point-of-collection placement means easy maintenance and fault isolation. ~$200–$400/unit.
Chlorine tablet flow-dosing	Viable alternative	Simple; removes the turbidity/particle problem. Main issues: ongoing supply chain and tablet-replacement logistics.
Point-of-use (home) chlorination	Possible complement	No clogging, minimal maintenance. Main risk: long-term adherence; people stop when they feel fine.
Liquid chlorine dosing (venturi / Zimba-type)	Not yet	Promising but not truly validated/commercial at this scale; venturi fails at low flow.
UV disinfection	Not preferred	Needs power and a 5 µm pre-filter (which clogs); less cost-effective than UF here.
Ozone	Ruled out	Too complex; needs electricity.

Option	Verdict	Why
Bare 0.1 µm membrane (no PRV/pre-filter)	Ruled out	Not designed for the system's pressure — too much pressure breaks it; too little is too slow.

The emerging direction: protect the source as much as possible, then place an independent ultrafiltration unit at the point of collection on selected spigots — with chlorination kept on the table as a per-village alternative or complement. Crucially, the team agreed this need not be one-size-fits-all: one village might maintain a UF unit, another might chlorinate at home, and another might choose untreated water for now.

Why an Earlier Chlorine-Generator Approach Didn't Stick

Early training on an electric chlorine-generation and bleach-making kit. The technology worked, but its manual operation proved impractical at this site — a central lesson driving the search for a passive solution.

The original project trained the community on an electric chlorine generator (which makes chlorine from salt and electricity) plus bleach-making kits. In practice that approach is no longer being used: it must be manually operated and powered (a car battery or solar), and nobody is going to walk three miles up the mountain to run it — and a solar panel left at the remote tank would likely be stolen. With thousands of users, a 40,000 L tank empties quickly, so manual batch chlorination can't keep up. **The takeaway driving every treatment decision: the solution must be passive, gravity-friendly, low-maintenance, and locally repairable.**

How the Team Is Organized: Three Work-Streams

The technical team divided the work into focused areas so specialists can move in parallel. Storage is treated as part of distribution.

Team 1 — Distribution System

Optimizing and extending the network of pipes, tanks, and valves. Three concrete design tasks:

1. Optimize the first distribution system (~2.2 km, ~10° decline).
2. Design the distribution expansion (~1.5 km, ~4° decline).
3. Design the second distribution system (~3.5 km, ~7° decline).

Key information still needed: main and branch pipe sizes, materials, and pressure ratings; exact storage-tank locations; and pressure-reducing-valve placement and specifications.

Team 2 — Safe Water (Removing Pathogens & Protecting the Source)

Goal: deliver safe water. Explore the cost-benefit of source protection, filtration (<0.1 µm), point-of-entry disinfection, and teaching villagers point-of-use chlorination — likely a combination rather than a single fix. This team owns the treatment trade-off analysis summarized above.

Team 3 — Legacy & Longevity Planning

Long-term vision, operations & maintenance (O&M), and the opportunities and constraints that determine whether the system survives for decades.

Opportunities

- A well-functioning distribution system already in place
- Communities willing to dig, lay pipe, build tanks, and fix problems
- Word of success has spread — every village wants a system
- Creeks/springs near uninhabited mountaintops can supply by gravity
- Reasonable elevation gradients
- Access to 4-wheelers when needed

Constraints

- Landslides can block or limit access to the source
- Storms introduce high turbidity
- No electricity
- No professional engineers; one local plumber
- Very limited access (nearest shipping town 10+ miles away)
- Community acceptance of untreated water (adherence risk)

The hardest-won lesson: build for the long term, not just the ribbon-cutting

Across the developing world, donors love to fund *new* construction but rarely fund long-term sustainability — so systems are built and then abandoned when a key person leaves, a committee stops collecting fees, or a part fails with no plan to replace it. Field experience on this team (including a decade-later survey of gravity-fed systems in the Dominican Republic) shows the water often still flows, but the *social* infrastructure — a functioning water committee, collected tariffs, a trained repair person — is what fails first. This project is being designed deliberately to avoid that trap.

What the Field Reports Tell Us

Two field updates from Philip document the second phase from launch to completion, and they confirm the model works on the ground.

Phase 2 Update — Korepa (Foe Villages)

The second phase extended the supply from the first phase's endpoint toward two adjacent communities. The community dug drains, carried sandbags up from the river, and installed tanks and taps. Reported challenges were notably human, not technical: low turnout on some workdays (a few dedicated individuals carried the load), disagreements over where shared taps should go (resolved by community meetings), and a steep drop point affecting pressure (addressed by erecting a metal stand). The update projected benefits including reduced waterborne disease, far less time spent fetching water (easing burdens on women and children), better school attendance, and help for smallholder coffee farmers.

Phase 2 Completion Report

Phase 2 launched in January 2025 and extended the supply from Kifidomeku village by 1.5 km to a neighboring village and hamlet. It added:

- 1 new water tank
- 8 tap stands, easier for community members to reach
- Water pipes laid through newly dug drains, connecting to the Phase 1 endpoint
- 3 gate valves along the pipe to regulate flow

The report states this brought clean, chlorinated water to over 1,500 additional people, for a total of more than 3,500 beneficiaries across both phases. One tap stand sits on a main road, so travelers and nearby communities benefit too.

Children celebrate as water reaches their hamlet for the first time

Two girls collect water at a new tap stand after school

In the community's own words

"We often walk far from home to collect drinking water but now we are very excited and happy that you have brought water to my doorstep. I assure you that we will look after this water supply and use it wisely."

— Gore Anidowe, Community Leader

"I represent all the mothers in this village because we often climbed mountains to collect good drinking water. Today, water is right at my doorstep. This is a valuable service, and I can't thank you enough."

— Rosa Wauweso, Women's Representative

Mrs. Wauweso opens a tap near her home.

Part 3 — Full Technical Detail & Reference

This part contains the complete engineering detail: site and hydraulic data, the per-spigot ultrafiltration design and operating protocol, the central-vs-distributed trade-off, parts lists, the supplier request, and the source records (team meeting and field notes). It is written for the people who will design, source, build, and maintain the system.

3.1 Site & Hydraulic Data

Storage and source

- **Main storage tank:** 40,000 L concrete (2 m × 2 m × 1 m tall), at the top of the system; fed from the creek.
- **Additional tanks:** a 9,000 L and a ~6,000 L tank higher up near the catchment; a third tank in the village steps water down toward lower communities.
- **Source:** a running creek. Some agricultural activity and animals nearby, but much less than near the villages. An older 1980s catchment exists further upstream (rusted out, now defunct) — a candidate for spring-capping / upstream extension.
- **Water quality note:** storms introduce turbidity into the main tank; an algae/taste issue was mitigated with a mesh cover and inlet/outlet strainers.
- **Power:** none on site. Solar is possible but unlikely to be used (theft risk in uninhabited areas). Gravity-based ideas are optimal.

Distribution lines, slopes, and pressure potential

Line / Segment	Length	Slope	Elevation drop	Pressure potential
First distribution system (existing)	~2.2 km	~10°	360 m	~36 bar
Expansion pipeline (Phase 2)	~1.5 km	~4°	100 m	~10 bar (from end of 1st system)
Second system (new tank, new villages)	~3.5 km	~7°	530 m	~53 bar

> **Why pressure is the central design constraint**
> On a gravity main, pressure is set by the **vertical height of water above a point** — not by pipe length or tank volume — and builds at roughly **1 bar per 10 m of vertical drop**. Over a ~360–530 m drop, static pressure at the lowest points can reach 36–53 bar, far beyond what PVC pipe, filter housings, or a UF module can survive. This is why the line already needs break-pressure management and why every treatment unit needs its own pressure-reducing valve.

Existing materials (sourced in Goroka town, carried to the village)

Item	Detail
Pipes	All system pipes are poly pipe; some sections use PVC joints. Inlet, outlet, and drainage at the catchment are mostly PVC connections.
Water tanks	All tanks are “Tuffa” tanks.
Taps & stands	Installed using 2 m, 20 mm galvanized pipes.
Catchment → first 5,000 L tank	50 mm poly
5,000 L tank → 9,000 L tank	40 mm poly
5,000 L tank → water tap #12	32 mm poly (main line ended here; designed for future extension)
Branches to taps #18, #16, #14	15 mm poly

Population served by section (first system)

Village / Taps	Approx. people
Village 1 — Taps #1, #2, #3, #17, #15	~400
Village 1 — Taps #4, #5, #6, #7, #8	~1,500
Village 1 — Taps #15 (shared w/ neighboring village)	~300
Village 2 — Taps #9, #10, #11	~350
Village 2 — Taps #13, #14	~500
Village 2 — Tap #12	~600

Note: *tap numbering in the source data has minor inconsistencies (e.g., #15 appears twice); treat these populations as planning estimates.*

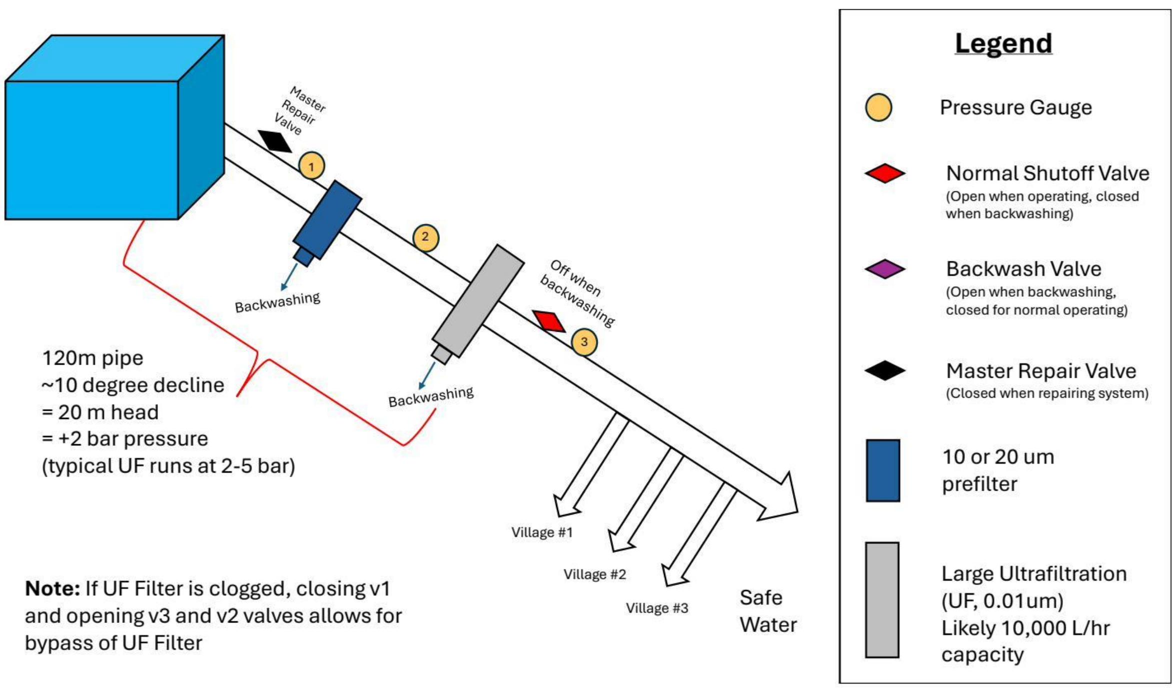
3.2 The Gravity-Fed Ultrafiltration (UF) Concept

The leading treatment design places an independent ultrafiltration unit at each village spigot — the last point before water leaves the pipe — rather than treating everything at one central point. Roughly seven units would cover the system. Each unit runs entirely on gravity head: no electricity, no chemicals, no manufactured consumables beyond replacement cartridges.

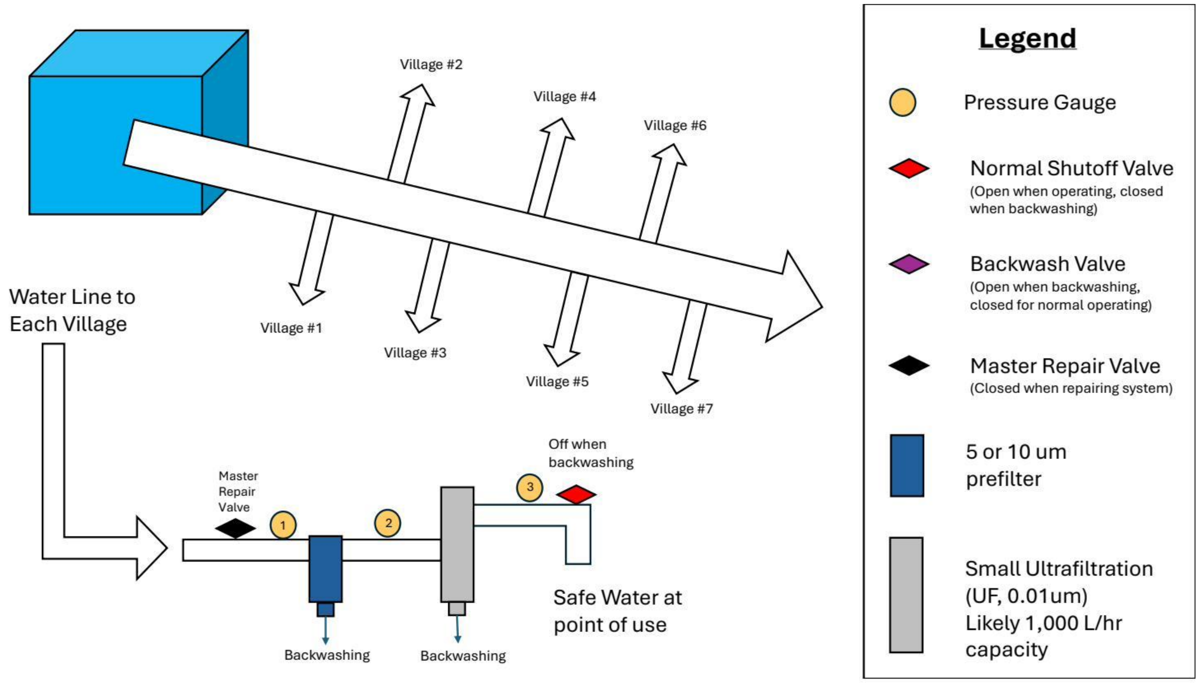
At the heart of each unit is a PVDF hollow-fiber UF membrane (about 0.01–0.03 µm) that physically blocks bacteria (cholera, typhoid; ~0.5–2 µm) and protozoan cysts (Cryptosporidium, Giardia; 4–6 µm). Two sediment pre-filters protect the membrane from silt, and a pressure-reducing valve protects the whole unit from the line's static pressure.

Central vs. per-spigot: the core trade-off

The team developed and compared two architectures. Both are viable; the per-spigot approach is judged slightly more beneficial, subject to supply availability and having a maintenance leader in each village.



Option A — one large filtration system near the top of the line. Valves allow the UF filter to be bypassed if it clogs.



Option B — a smaller filtration unit at every spigot, at the point of collection. Each village maintains its own unit.

	Option A: One central unit	Option B: One unit per spigot
Cost	Lower (~$1,000 incl. shipping)	Higher in total (~$200–$400 each × ~7)
Install	One install point, ~1 day	7+ install points
Maintenance	Harder — 2+ km uphill walk to reach it	Easy — right at the point of use
Consumables / parts	Fewer	More
Failure behavior	Single point of failure; a clog or breach can cut water to 3,000+ people until fixed/bypassed	Fault-isolated; one clogged unit affects only one village
Load on membrane	Sees all flow; clogs faster in a turbidity event	Self-regulating — each membrane sees only its village (~2,000 L/day), fouls slowly
Theft exposure	Parts concentrated at one secured point	No high-value parts, but spread across villages

The trade-off to accept (per-spigot)

The membrane removes pathogens but leaves **no chlorine residual**. Because filtration happens at the point of collection, there is essentially no pipe downstream to protect, so no residual is needed. The one remaining exposure is contamination at the spigot or in the collection container (a dirty hand or jug) — which no upstream treatment fully solves and which is out of scope for this unit.

3.3 UF Unit — Hydraulics, Flow Path & Components

Hydraulics (per unit)

- **Pressure-reducing valve (PRV) is mandatory.** It brings local pressure down to the UF/housing working range, about 2–3 bar. This single component is what lets one standardized unit work at every spigot regardless of elevation.
- **Two PRV ratings matter (different numbers):** the set outlet pressure (target ~2–3 bar), and the maximum inlet pressure rating (must exceed the worst-case static pressure at the lowest spigot where a unit is installed). A PRV set to 2–3 bar out can still be destroyed if incoming static pressure exceeds its inlet rating.
- **Deliberate oversizing is the fouling buffer.** At ~2–3 bar, flow is limited by the pipe and spigot, not the membrane. A 2,000–3,000 L/hr module serving ~2,000 L/day runs at a small fraction of capacity, so it can lose much of its clean permeability and still pass the village's flow — stretching out time between backwashes and extending membrane life.

Flow path and component order (inlet → outlet)

#	Component	Purpose
—	Tap off the main line at the spigot	Connection point
PRV	Pressure-reducing valve	Set to ~2–3 bar out; protects everything downstream
S1 → G1	Shutoff valve 1 → Pressure gauge 1	Isolate stage; G1 reads PRV output / into Stage 1
Stage 1	Spin-down pre-filter (40–50 µm stainless screen)	Removes coarse sediment; manual bottom flush valve
Stage 2	5 µm PP melt-blown cartridge (big-blue/white housing)	Removes finer particles / biofouling load
S2 → G2	Shutoff valve 2 → Pressure gauge 2	G2 reads pressure into the UF
UF	PVDF hollow-fiber module (~0.01–0.03 µm, 2,000–3,000 L/hr)	Removes pathogens; open-bottom direct backwash
S3 → G3	Shutoff valve 3 → Pressure gauge 3	G3 reads pressure out of the UF, to the tap
—	Spigot / collection tap	Point of safe-water collection

Layout notes

- Three shutoff valves, one immediately before each gauge (S1→G1, S2→G2, S3→G3), so any stage can be isolated and depressurized for service.
- No separate backwash piping: both the spin-down pre-filter and the UF module are bought as direct-backwash devices (twist-to-flush at the bottom). There are no V3/V4 backwash branch valves.
- The 5 µm cartridge is not backwashed — it is unscrewed and rinsed or replaced.
- The PRV sits first so everything downstream only ever sees the reduced ~2–3 bar working pressure.

3.4 UF Unit — Parts List (per unit; × ~7 for the full system)

#	Part	Spec / note	Qty
1	Pressure-reducing valve (PRV)	Adjustable, set ~2–3 bar out; max inlet rating ≥ worst-case head at spigot	1
2	Stage 1 pre-filter	Spin-down, 40–50 µm 316/316L steel screen, manual bottom flush valve	1
3	Stage 2 housing	“Big blue” / white 10″ housing with isolation/relief button	1
4	Stage 2 cartridges	5 µm PP melt-blown, sized to housing (buy in bulk)	5–10
5	UF module	PVDF hollow fiber, ~0.01–0.03 µm, 2,000–3,000 L/hr, direct open-bottom backwash	1
6	Pressure gauges	0–6 bar (0–90 psi), glycerin-filled; G1, G2, G3	3
7	Shutoff (ball) valves	Full-bore, matched to line size; S1, S2, S3	3
8	T-fittings	Gauge ports for G1, G2, G3	3
9	PVC pipe, fittings, cement, sealant	Sized to line (1/2″–3/4″)	as needed
10	Lockable enclosure / fence	Theft and tamper protection at each spigot	1
11	Turbidity tube / clarity jar	Judge source water during storms (can share across units)	1

Sourcing notes

- **Imported as a bundle:** the PRV, spin-down pre-filter, 5 µm housing + cartridges, and UF module (likely a single supplier — see the RFQ in 3.6).
- **Locally available:** ball valves, gauges, PVC, fittings, and enclosures.
- **Main recurring consumable:** 5 µm PP cartridges — buy a lot. Replacement UF filters are only ~$20–$30 each; ship 3+ per system with the initial order.
- **Match each PRV to its spigot’s elevation:** lower spigots need PRVs with higher inlet ratings. Confirm static head at each before ordering.

3.5 UF Unit — Installation, Operation & Maintenance

Installation (per unit)

1. Prepare the spigot location: build the lockable enclosure; ensure stable mounting and drainage for flush water.
2. Tap the main line; install the PRV first, then set outlet to ~2–3 bar.

3. Assemble the train in order: PRV → S1 → G1 → spin-down → 5 µm housing → S2 → G2 → UF → S3 → G3 → spigot. Use sealant on threads, cement on PVC; let joints cure before pressurizing.
4. Fit gauges at G1, G2, G3; position spin-down and UF bottom-flush to discharge to a drain, clear of the clean tap.
5. Confirm default valve positions: PRV set; S1/S2/S3 OPEN.
6. Set the PRV: with the downstream tap cracked open, adjust until G1 reads ~2–3 bar under flow.
7. Commission slowly: open the main tap gradually so the unit fills gently and air bleeds out — avoid slamming pressure onto a dry membrane.
8. Record baseline gauge readings (G1, G2, G3) with the tap open, on a card inside the enclosure. These clean-unit numbers are the reference for all future maintenance.

Reading the three gauges (diagnostics)

Always read gauges under the same condition — tap open and flowing — so readings compare over time.

- **G1 drifting from ~2–3 bar** → the PRV needs re-adjustment or inspection.
- **G1 − G2 rising** (pressure drop across the pre-filters) → pre-filters are loading with sediment. When the gap roughly doubles vs. the clean baseline, flush the spin-down and/or rinse-replace the 5 µm cartridge.
- **G2 − G3 rising** (pressure drop across the UF) → the membrane is fouling. When the gap grows beyond baseline, backwash the UF.

Without gauges, the field signal is simply the tap running weak. The two middle readings tell you which stage is responsible instead of guessing.

Maintenance schedule (per unit)

Interval	Task
Weekly (and after heavy rain)	Read G1, G2, G3 with the tap open; record. Glance at the 5 µm housing if visible.
Routine, easy	Twist the spin-down flush valve for a few seconds to purge grit — quick and frequent is ideal.
When G1−G2 climbs	Flush the spin-down; if still high, rinse or replace the 5 µm cartridge.
When G2−G3 climbs / tap weak with clean pre-filters	Backwash the UF.
When G1 drifts off ~2–3 bar	Re-adjust or inspect the PRV.
Every few months	Check valves move freely; inspect enclosure lock and fence.
Long-term (often 1–3 years)	Replace the UF module when backwashing no longer restores flow.

The gauges, not the calendar, are the real trigger. Creek turbidity drives everything: clear water means long intervals; storm-muddy water means frequent spin-down flushing. Because the spin-down flush is a simple twist at the collection point, doing it often and preemptively is the cheapest way to protect the cartridge and the membrane behind it.

Procedures (summary)

Procedure	Key steps
9A — Flush spin-down (routine)	Under pressure, direct flow to drain, open bottom flush valve (twist) a few seconds, close. No need to isolate.
9B — Rinse/replace 5 µm cartridge	Close S1; relieve pressure (confirm G1/G2 fall to ~0); unscrew housing; rinse or replace cartridge; reseat; reopen S1; refill gently; re-read gauges.
9C — Backwash the UF (open-bottom)	Close S2 and S3; open the UF bottom backwash/drain; let residual pressure flush solids until clear; close; reopen S2/S3; refill gently; re-read G2−G3 (near baseline = success).

Failure modes

Symptom	Likely cause	Action
Tap weak; G1−G2 high; G2−G3 normal	Pre-filters clogged	Flush spin-down (9A); rinse/replace 5 µm (9B)
Tap weak; G2−G3 high; G1−G2 normal	UF fouled	Backwash UF (9C)
Tap weak; backwash doesn't restore flow	UF near end of life	Replace UF module
G1 not holding ~2–3 bar	PRV drifting/failing	Re-adjust / inspect / replace PRV
High pressure reaching filters; parts straining/leaking	PRV failed open	Close S1 immediately; service PRV before resuming
Flow fine but water looks cloudy at the tap	Possible membrane breach	Stop use; inspect UF and seals before resuming
Flow crawls only during storms	Source turbidity overwhelming pre-filters	Flush spin-down frequently; wait for creek to clear

The two failures to treat urgently

Cloudy water at the tap is the only failure that could pass unfiltered water — take that unit out of use until inspected. A **PRV failure-open** exposes downstream parts to full line pressure — close S1 first, then service. Clogging failures are benign: they slow flow, they do not pass bad water.

3.6 Pilot Pre-Filter/UF Project & Supplier Request (RFQ)

Pilot inlet detail

- **Inlet:** 15 mm HDPE water-supply coil tubing (≈ ½″).
- **Adapter:** 15 mm → ¾″ male threaded adapter (MTA) expansion.
- **Why expand to ¾″:** ½″ → ¾″ increases dispersion across the membrane by reducing internal friction — spreading pressure and water evenly across the membranes. The inlet port to the pre-filter/UF system performs better at ¾″ than ½″.
- **Connection:** use ¾″ threaded nipples or a ¾″ high-flow braided hose; end with ¾″ pipe for maximum flow.

Request for Quotation (Alibaba) — as submitted

> **Point-of-Entry 3-Stage Filtration Set (Spin-down 40 µm + 5 µm + 2,000+ L/h PVDF UF)**
> **Context:** Sourcing a single supplier to quote and package a 3-stage point-of-entry filtration set for a gravity-fed system with significant static pressure (not standard household mains) — so confirm pressure ratings on every component. Requesting a paid sample of 1–2 complete sets first, with intent to reorder 10+ sets (and potentially 100+ units/yr under a large grant). For an NGO clean-water project in Papua New Guinea.
>
> **Stage 1 — Spin-down sediment pre-filter:** 316/316L stainless screen, manual twist/ball flush valve for backwashing. State the finest screen micron rating available (e.g., 40 µm or finer) and quote the finest you can supply.
>
> **Stage 2 — Sediment cartridge housing:** 1× "big blue" / white 10″ housing (non-transparent), with shutoff/isolation valve for rinsing. Include 5× PP replacement cartridges rated 5 µm (not 1 µm).
>
> **Stage 3 — Ultrafiltration module:** Stainless housing, PVDF hollow-fiber membrane, rated 2,000–3,000 L/hr (send options), backwash/reverse-flush capable. All three stages must be mutually compatible, easily connected, and share inlet/outlet diameters (ideally ¾″, ½″ acceptable).
>
> **Confirm for each stage:** maximum working pressure (bar) for Stage 1, the Stage 2 housing, and the Stage 3 UF module; and whether a pressure-reducing valve (PRV) rated to protect these components can be supplied, with its quote.
>
> **Thread & logistics:** ¾″ (preferred) or ½″ BSP. Ship to Goroka, Papua New Guinea, Postcode 441 — confirm shipping, method, and lead time. Provide itemized per-component pricing and a single bundled total including shipping; state MOQ and per-set price at a 6-set reorder quantity.

Cost ballpark (team estimates): small multi-spigot unit ~$400 (single) / ~$200 (in quantity); large single central system ~$1,000 incl. shipping. UF replacement filters ~$20–$30 each.

3.7 Appendix A — First Technical Team Meeting (Jun 10, 2026)

Summary. The team reviewed the existing projects and set engineering protocols for sustainable, long-term infrastructure. Community engagement is central — manual labor and local organization have already reached ~3,000+ residents. Google Earth analysis confirms an elevation drop of nearly 1,000 ft suitable for gravity feed. Treatment needs optimization given power and logistics constraints. The team will standardize documentation and rigorously vet every technology, prioritizing simple, repairable designs.

Decisions

- **Collaborative documentation:** use a centralized shared doc for brainstorming instead of email.
- **Topic-specific structure:** separate documents per topic rather than one consolidated file.
- **Four categories:** source protection, distribution, treatment, and legacy/longevity (opportunities & constraints).
- **Barebones to start:** let content evolve naturally during development.
- **Dedicated technical drive:** kept separate from administrative/funding files.

Next steps

- **Treatment email thread** (Byran, Danielle, Deena) — discuss treatment options and design perspectives.
- **Identify the source** (Philip) — research whether spring-capping is viable; provide photos/video of the source.
- **Create shared drive** (Byran) — with the four topic documents; upload media.
- **Map populations** (Byran + Philip) — estimate village populations along the route via Google Earth; build a lat/long table of communities, sources, and diversion points.

Selected technical discussion points

- **Skin in the game:** community ownership and a strong local leader are the difference between systems that last and “parachute” projects that are abandoned within a year.
- **Earlier chlorine generator not in use:** manual operation (walking miles uphill, managing batteries) is impractical; alternative treatment is a major objective.
- **Source first:** capping a spring or extending upstream could minimize the need for chemical/filtration treatment; upper slopes are largely untouched, agriculture is downhill.
- **UF at specific taps:** a cost-effective option (~$1,000–$2,000 range discussed) implemented at tap locations so maintenance stays manageable.
- **No reliable electricity; solar theft risk:** solutions must need minimal power, and only where secure/populated.
- **Plan infrastructure for 20 years:** size pipes and tanks for future growth now — you can scale treatment in later, but you only lay the infrastructure once.
- **Shut-off valve spacing is critical:** enough valves let crews isolate sections for repairs and new connections without long downtime.

- **Design for repairability and redundancy:** “make it break easy so you can fix it easier” — favored alongside robustness.
- **Legacy planning:** functioning water committees, collected tariffs, and trained repair people are what fail first; plan for them deliberately.
- **“Guilty until proven innocent”:** vet every technology against the real field environment; gravity-flow itself is centuries-proven.

Who was involved (technical team)

Leaders: Philip Wayaki Bongi (project originator; bridges technical, funding, and community) and Shelby Defeo (water quality; initiated the partnership). **Clean Water Help:** Byran Fuhrmann, Deena Hannoun (VP; applied mathematics). **Volunteer experts:** Danielle Wain (water engineer; gravity-flow systems, Peace Corps; lake science), Jonathan Martin (watershed hydrology), Russ Bergholz (25+ yrs civil engineering — distribution systems, tanks, pump stations). Additional invitees from partner organizations also participated.

3.8 Appendix B — Field Report Highlights

Phase 2 Update (Korepa / Foe Villages)

- Extended supply from the Phase 1 endpoint toward two adjacent communities; one tank installed, more planned (pressure-dependent); 7 taps installed by the plumber.
- Each household contributes K20 (~USD $4) to a repair fund for pipes, taps, and tanks.
- Challenges: low workday turnout; disagreement over tap locations; a steep drop point affecting pressure (metal stand planned).
- Expected to benefit ~1,500 people; a roadside tap also serves passing communities.

Phase 2 Completion Report

- Launched January 2025; extended supply 1.5 km from Kifidomeku village to a neighboring village and hamlet.
- Added 1 new tank, 8 tap stands, pipe through new drains to the Phase 1 endpoint, and 3 gate valves for flow regulation.
- Provides clean, chlorinated water to 1,500+ additional people; 3,500+ total across both phases.
- Documented impacts: reduced typhoid; less time fetching water (safer for women/children); easier access for the elderly; better school attendance; productivity gains for coffee and broiler-chicken farmers.

Inspiring story — Paul Sasu

Community members mix cement for the water catchment built during Phase 1.

Paul Sasu knew the water would stop about a kilometer short of his house, yet he walked 3 km to the source to help — carrying 50 kg cement bags, bricks, and sand up the steep hill, and enduring ridicule from clansmen who thought he was wasting his time helping another village. He never wavered. Now he is leading his own clansmen to dig the drain from the Phase 1 endpoint to his village and helping the plumber lay pipe. After about ten months, water will finally reach his home. His story captures the community spirit this whole model depends on.

3.9 Appendix C — People, Partners & Communications

Philip — project leader; started the original system; the only one in his family to attend college. The village had safe water in the 1980s, but it rusted out. Philip saw the burden (miles of walking for water), reached out to multiple organizations, and a supporting NGO responded — funding the first ~2.5 km to reach ~3,500 people.

Elan & Carey — Carey (Elan's mother), a former director for a health network in PNG, connected Elan with Philip. Elan ran GoFundMe efforts and wrote an article (published and shared on LinkedIn) that raised awareness and funds for the ~1.5 km extension.

Local leadership & sustainability: two community leaders were given smartphones to report problems, send photos, and give updates. A community fund (~K20/$4 per household) covers repairs. The concrete cistern (2 m × 2 m × 1 m) fills by gravity from a nearby creek and feeds the ½–¾″ flex line downstream; a local plumber troubleshoots (early high pressure broke pipes and required expert support).

Two big-picture goals (Marketing/Comms)

- **Raise money to expand:** grow the distribution from the first system and build another system (led by Elan, Carey, and Philip).
- **Write a grant to scale across Eastern PNG:** Coca-Cola is a high-priority target (led by Deena, Emily, and Bash).

Useful conversions: K20 ≈ USD $4; 4 m³ = 4,000 L; "big" tank references include 40,000 L (main), 9,000 L, and ~6,000 L.

3.10 Appendix D — Open Questions & Information Still Needed

Area	Still needed
Distribution	Main & branch pipe sizes, materials, and pressure ratings; exact tank locations; PRV placement and specs.
Treatment	How often the source runs “muddy” (turbidity frequency); confirmation of static head at each spigot before ordering PRVs.
Source	Whether the upstream 1980s catchment / a spring cap is viable for source protection.
Supplier	Confirmed pressure ratings per stage; UF backwash method and flow/pressure limits; shipping method and lead time to Goroka (Postcode 441); MOQ and 6-set reorder pricing.
Planning	20-year population projections per village; lat/long table of communities, sources, and diversion points; long-term O&M cost model and personnel sustainability plan.

3.11 Appendix E — Source Materials

This master document consolidates the following project files:

- PNG Project Summary (executive blueprint and four-phase plan)
- General Knowledge Document — Knowns, Unknowns & Needs (site data, materials, populations)
- PNG — UF System Concept (per-spigot ultrafiltration protocol)
- Ultrafiltration PNG Design Concept (central-vs-distributed diagrams and trade-off)
- Details for the pilot pre-filter/UF project & RFQ (sourcing request)
- Team 1 — Distribution System; Team 2 — Safe Water; Team 3 — Legacy & Longevity Planning
- First Technical PNG Team Meeting notes & transcript (Jun 10, 2026)
- Water Supply Project Update (2nd Phase) and Phase 2 Completion Report
- PNG Marketing/Comms Team intro meeting notes
- GPS / Google Earth community markings; photos of the first system

Interactive Google Earth model: earth.google.com (project area)

End of document — Clean Water in Papua New Guinea: A Blueprint for Scalable Infrastructure