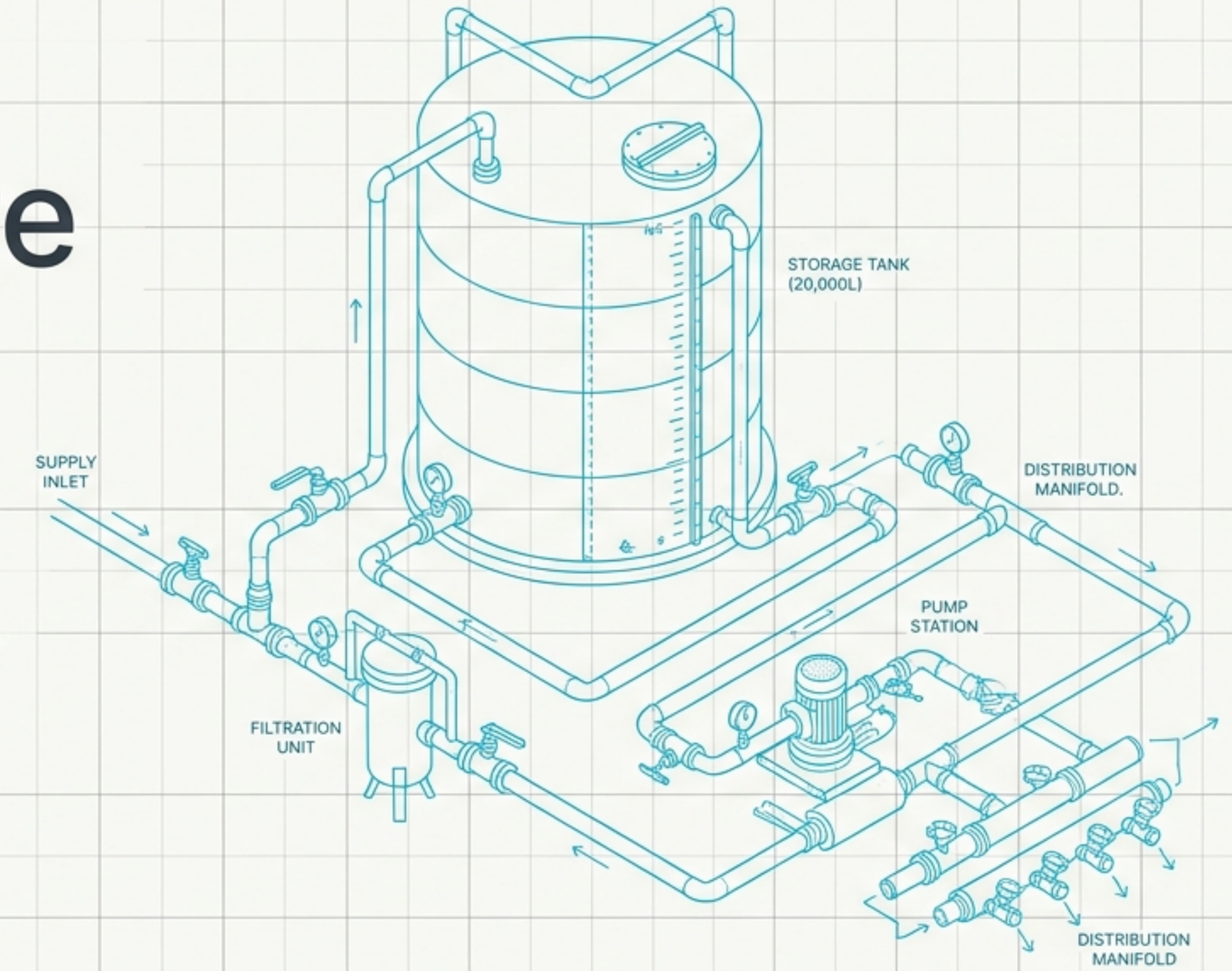
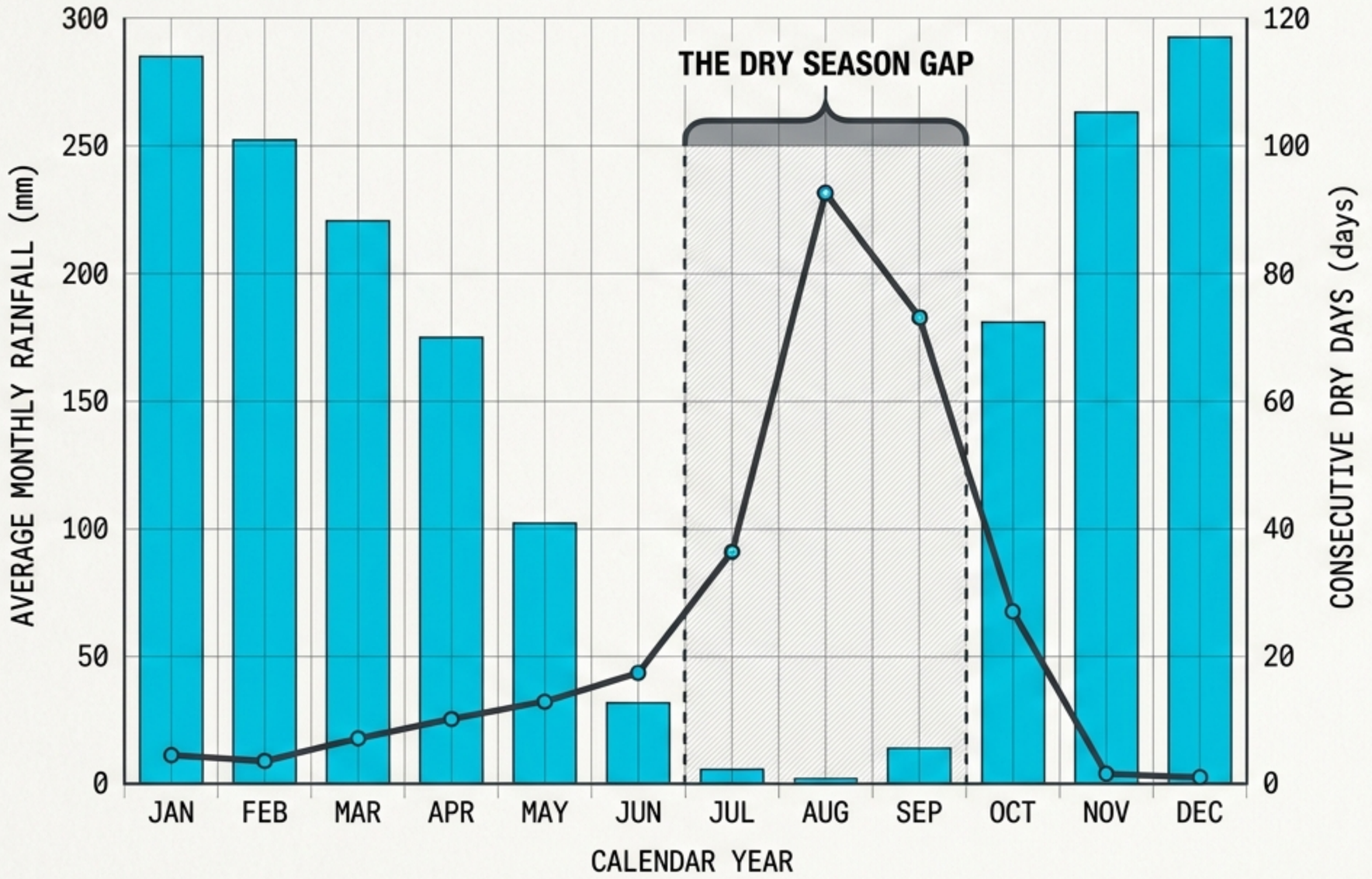
Water Infrastructure Blueprint

Design, legalisation, and implementation strategy for off-grid water systems at the Lusitano Retreat.



Norte Portugal | Operations & Engineering Roadmap | June 2026

HYDROLOGIC PROFILE: NORTHERN PORTUGAL (Annual Cycle)



THE NORTE PORTUGAL ENVIRONMENTAL BASELINE

HIGH ANNUAL RAINFALL (1,003–1,161 mm) PAIRED WITH EXTREME SUMMER DROUGHT.

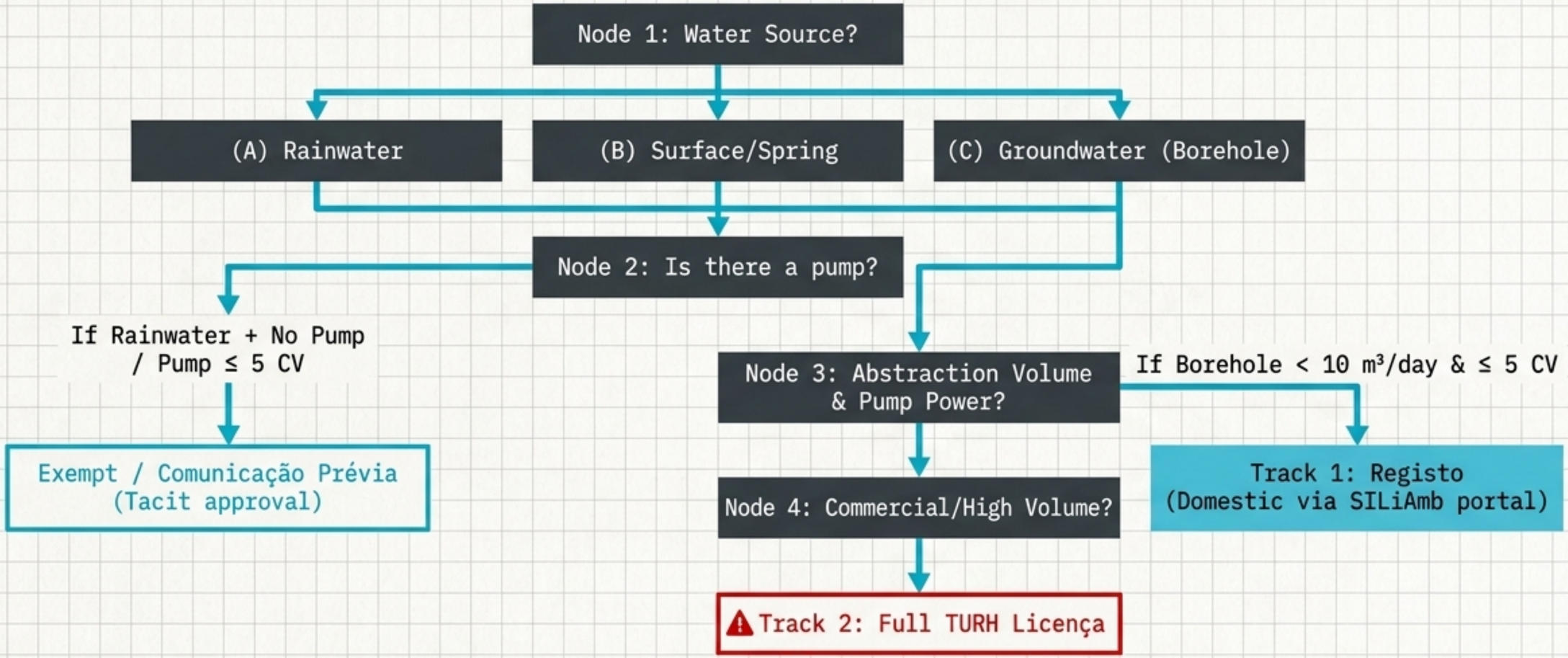
THE GOLDEN RULE

10 GUESTS DRAWING 100 L/DAY OVER A 90-DAY DRY SEASON REQUIRE 90,000 L.

ACCOUNTING FOR MINOR SUMMER RAIN, 80,000 L MINIMUM CARRY-OVER STORAGE IS THE MATHEMATICAL PREREQUISITE FOR YEAR-ROUND OFF-GRID SURVIVAL.

TAKEAWAY: YOU CANNOT RELY ON SEPTEMBER RAIN TO FILL AN EMPTY SYSTEM ON ARRIVAL. PRE-FILLING IS MANDATORY.

The Compliance Gateway (DL 226-A/2007)



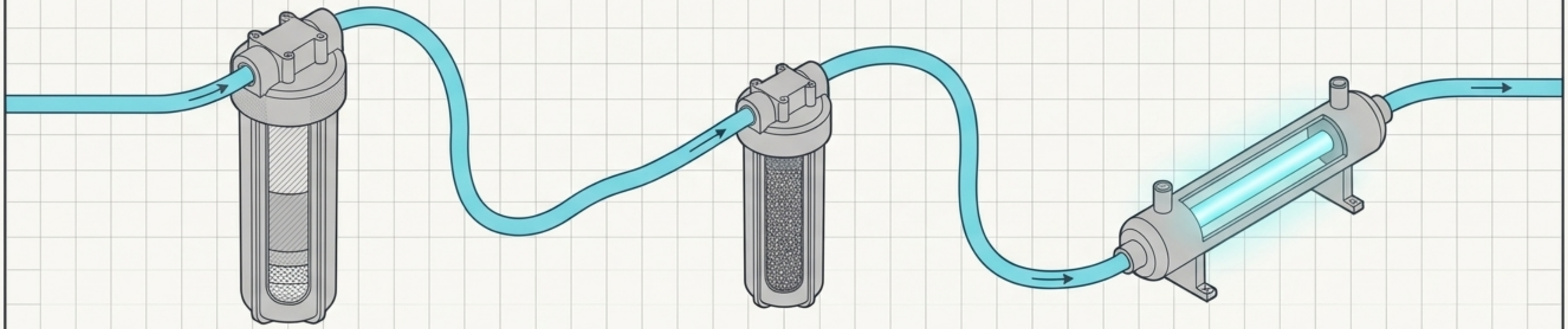
Key Warning: All boreholes must be registered with APA/ARH Norte prior to drilling. Drilling without registration risks severe fines.

Source Diagnostic Matrix

Source	Annual OpEx	Legal Risk	Health Risk	Potability Status
Rainwater (Roof)	~€0	Low (No TURH for cistern)	Low-Med	Safe only with full treatment (bird droppings).
River/Stream	~€0	Medium (≤5 CV pump)	HIGH (Cryptosporidium/E. coli from cattle)	Unsafe without heavy multi-barrier treatment.
Spring (Nascente)	~€0	Low-Med	Medium	Safe with UV + Lab Certification.
Borehole (Granite)	€50–150/yr	Medium (TURH Req.)	Medium (Radon, Iron/Mn)	Highly reliable, requires pH/aeration/UV.
Municipal Supply	€109–316/yr	None	Low	Readily potable; high ramal connection costs beyond 20m.

The Multi-Barrier Philosophy

No single component ensures safety. Pathogen removal requires an interdependent sequence.



Stage 1: Sediment Filtration (5 µm → 1 µm)

Function: Removes physical particles.

Dependency: Mandatory because UV efficacy fails completely if turbidity exceeds 1 NTU.

Stage 2: Activated Carbon

Function: Adsorbs organics, humic acids, and removes chlorine.

Dependency: Must be placed before UV, as carbon beds harbor biofilm bacteria.

Stage 3: UV Disinfection (40 mJ/cm²)

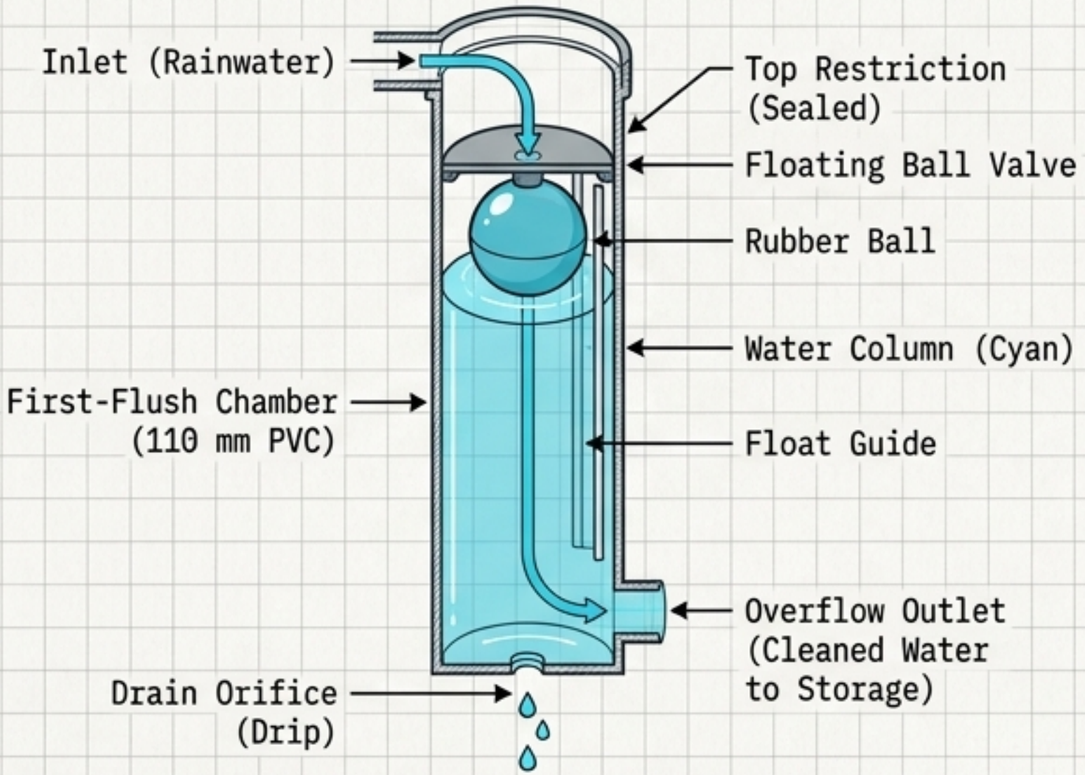
Function: Inactivates viruses and bacteria.

Dependency: Requires crystal-clear water from Stage 1 to penetrate pathogen DNA.

⚠ Chlorination alone is legally and practically insufficient against *Cryptosporidium*. Physical filtration or UV is mandatory.

Kit of Parts: Capture & Storage

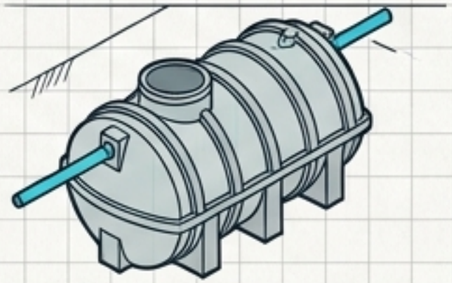
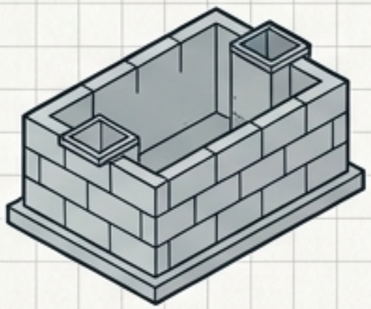
The Mechanism



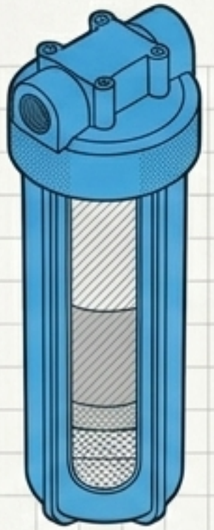
Visual Annotation (The First-Flush Mechanism)

Discards the first 1-2 mm of rainfall containing 90% of roof contaminants (bird droppings, heavy metals). A 100 m² roof requires a 100-150 L DIY diverter (110 mm PVC, ~€30). Drain orifice empties chamber over 4-8 hours.

Storage Catalog

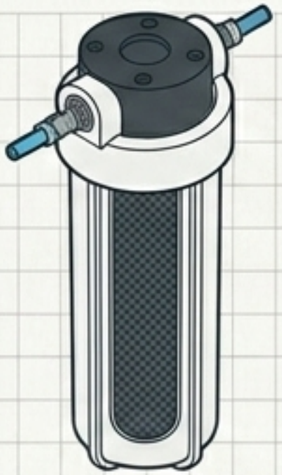
	**IBC 1000 L** Used, food-grade (UN31HA1). Must be painted black. ~€45 (Fafe/Braga).
	**Underground Polyethylene** Maintains 10-14°C, prevents algae. 10,000 L = €3,369 (FelixEnergy).
	**Concrete Cisterna** Local granite/masonry build. 5,000 L = ~€1,200-€2,100.

Kit of Parts: Filtration & Treatment Array



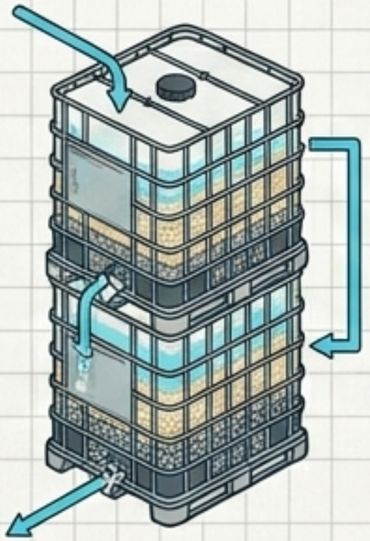
Sediment Housing

Big Blue 20"×4.5" single housing (€85). 5-micron melt-blown cartridge (€4.10, FiltroShop).



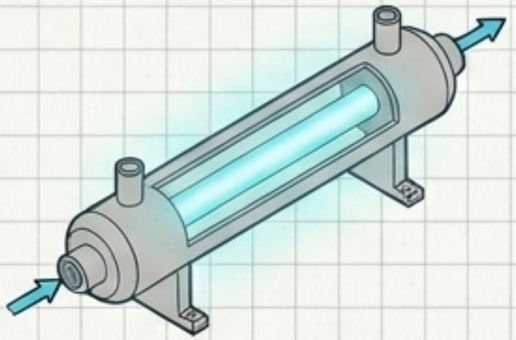
Carbon Block

10" housing, 1-micron CTO block. Removes organics/odors. (€9.50 cartridge).



Slow Sand Filter

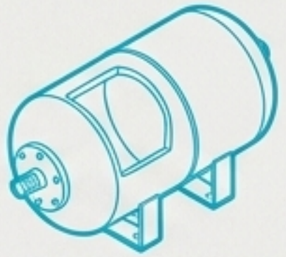
DIY biological filtration (Schmutzdecke). Requires 2 stacked IBCs + 0.4–0.6mm silica pool sand (€72/6 bags). Removes >99% bacteria.



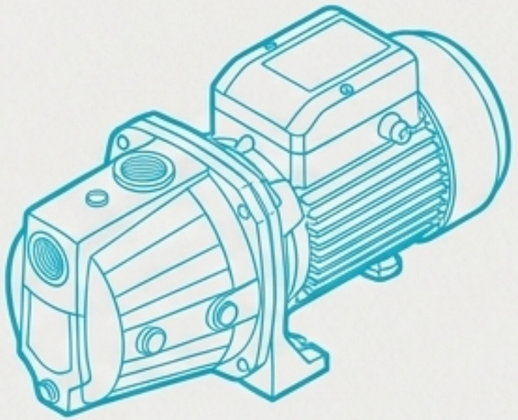
UV Sterilizer

Innest 30L (LED, €329) or VIQUA VH200 (NSF 55 Class A, 34 L/min, ~€900). Annual lamp replacement mandatory.

Kit of Parts:
Pressure & Distribution

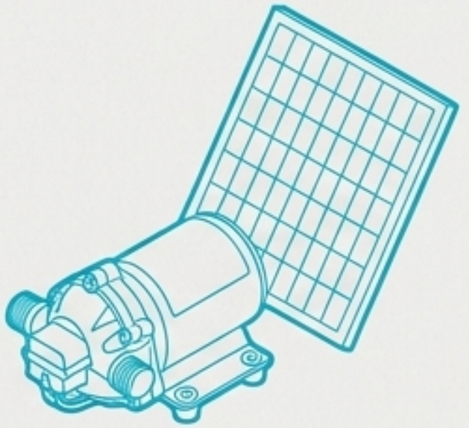


Pressure Vessel (Accumulator)
Prevents pump short-cycling.
Mandatory Rule: Must be **INOX 304 + EPDM** membrane for potable water. 100 L = €259.



Surface Jet Pump
Best for cisterns/shallow wells (<7m head).
Spec: Pedrollo JSWM 2C.
Cost: ~€302.

Submersible Pump
Best for deep granite boreholes (20-80m).
Spec: DAB Pulsar or Grundfos SP5.
Cost: €420-€1,000+.

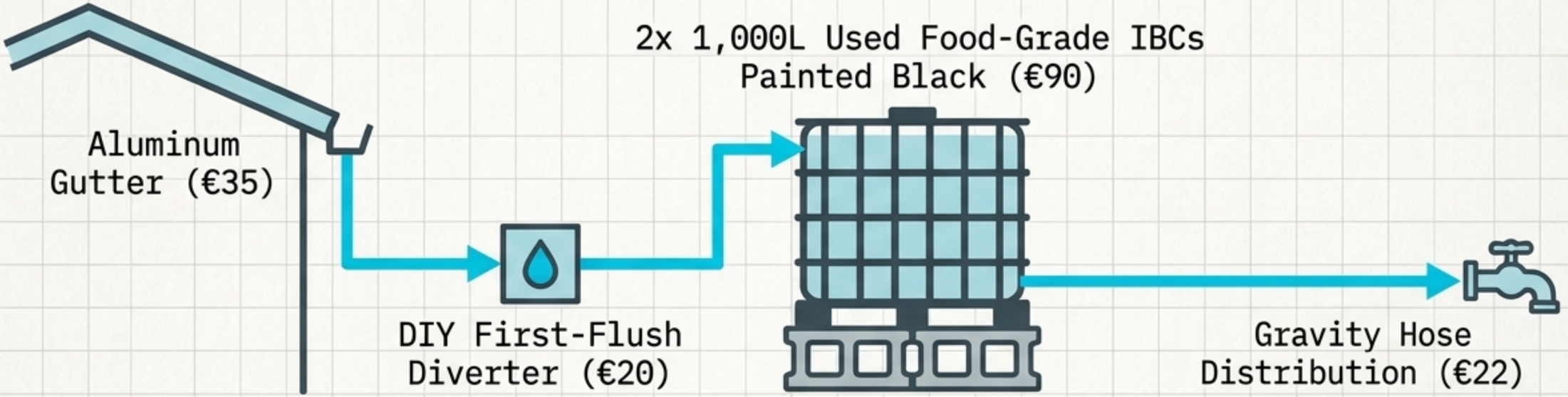


Solar Demand Pump
Best for build sprint surface lift.
Spec: Shurflo 2088 24V.
Cost: ~€178.

The Three-Tier Strategic Roadmap

Level A (Build Sprint MVP)	Level B (Small Retreat)	Level C (Large Building)
Target: Sept 2026.	Target: First Guests.	Target: Full Operations.
Capacity: 2–5 pax.	**Capacity:** 8–15 pax.	**Capacity:** 20–50 pax.
Architecture: Roof -> First-flush -> IBCs (Non-potable) + Bottled water.	**Architecture:** Rain/Borehole -> 10,000L Cistern -> Full Treatment Train -> Taps.	**Architecture:** Borehole (1st) / Rain (2nd) / Mains (3rd) -> Complex Treatment & Break Tanks.
Budget: ~€321–€600.	**Budget:** €4,000–€12,000.	**Budget:** €20,000–€45,000.

Level A: Ultra-Low-Cost DIY MVP



Critical Constraint

Gravity pressure from 0.5m elevation is only ~0.05 bar. Sufficient for tools and washing, not pressurized showers.

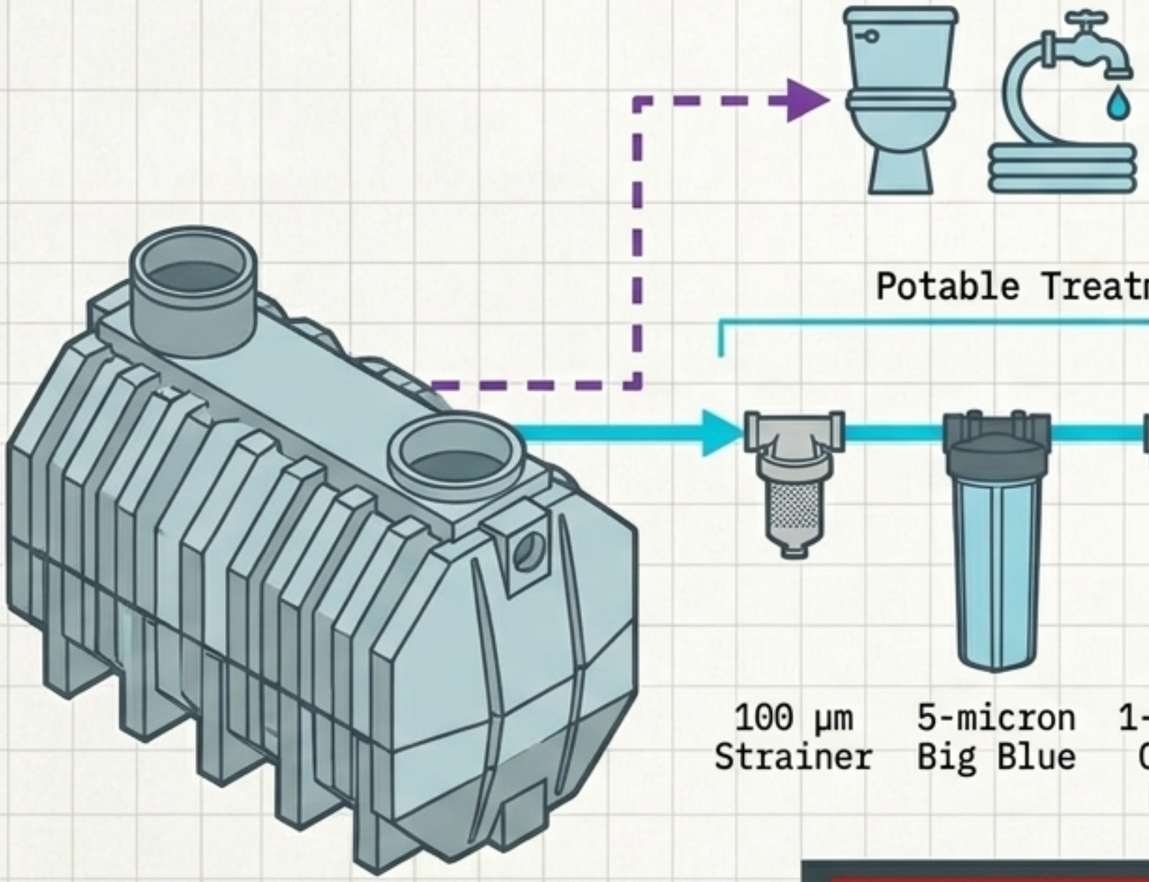
Drinking Strategy

53x 5L jugs of commercial bottled water (~€48) for 5 people over 21 days.

Safety Warning

Do NOT drink IBC roof-collected water. A ceramic filter backup (€80) is viable only on clean stream water, never on IBC roof water.

Level B: Safe Small Retreat System



10,000L Underground Cistern (€3,369)

Dual Circuit Logic: Non-potable circuit (toilets/irrigation, screened only).

Potable Treatment Train

100 µm Strainer

5-micron Big Blue

1-micron Carbon Block

Innest 30L UV Sterilizer (€329)

Pressure Delivery: Pedrollo Surface Pump

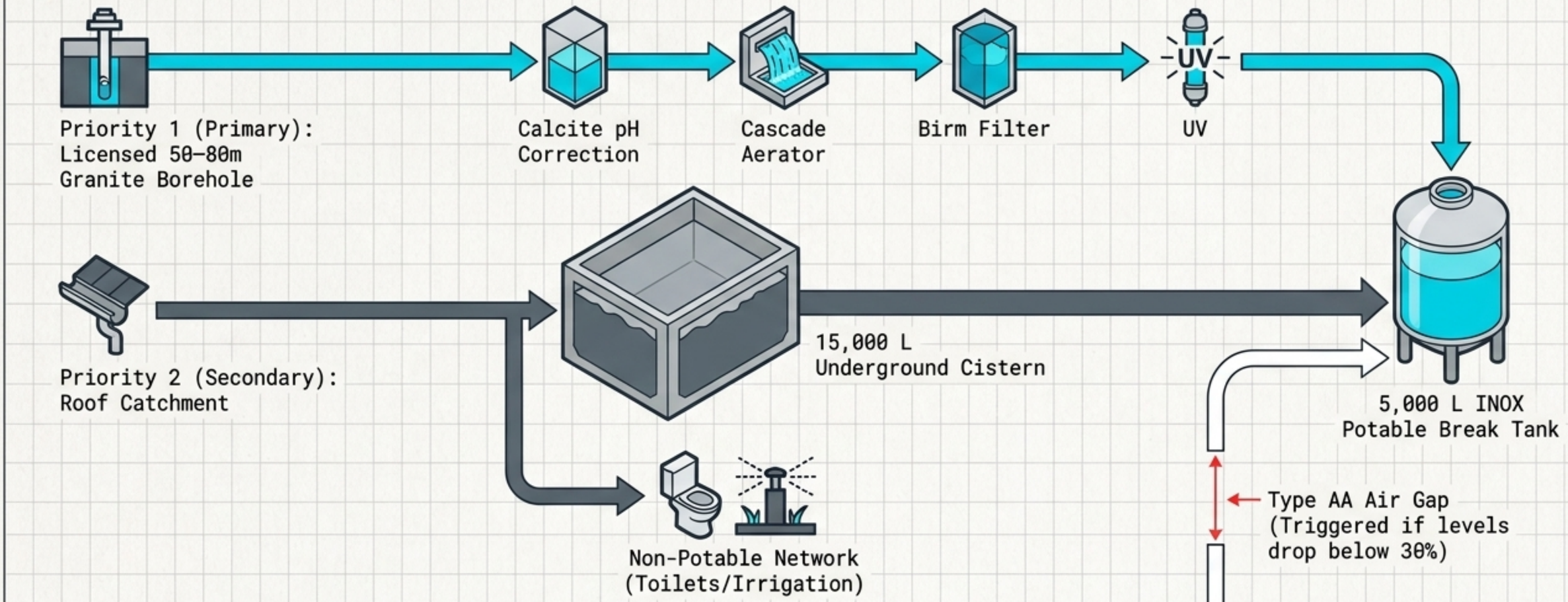
100L INOX 304 Accumulator

→ Distribution.

Legal Checkpoint

Requires ACES notification and IPAC-accredited lab analysis (AquaValor) before AL/RNAL licensing.

Level C: Scalable Multi-Source Architecture



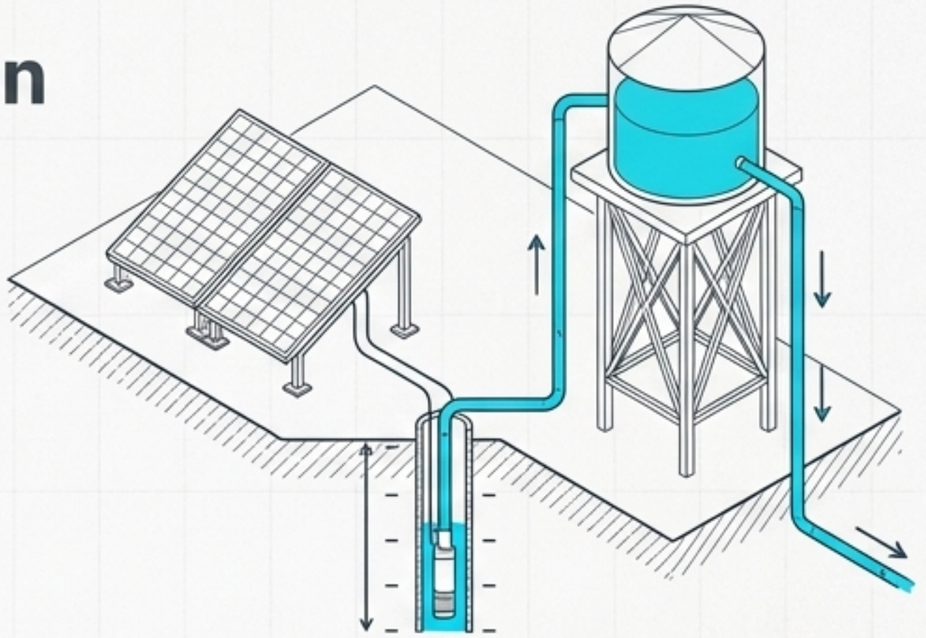
Scale: Capable of sustaining 3-day peak demand (7,500 L/day).

Level C: Advanced Integration

Solar Pumping Array

Grundfos SQFlex 3 SQF-2 pump paired with 2x 200W monocrystalline panels. Yields sufficient lift from 50m even on overcast Norte PT winter days.

Pumps to a 6m elevated header tank for battery-free gravity pressure at night.

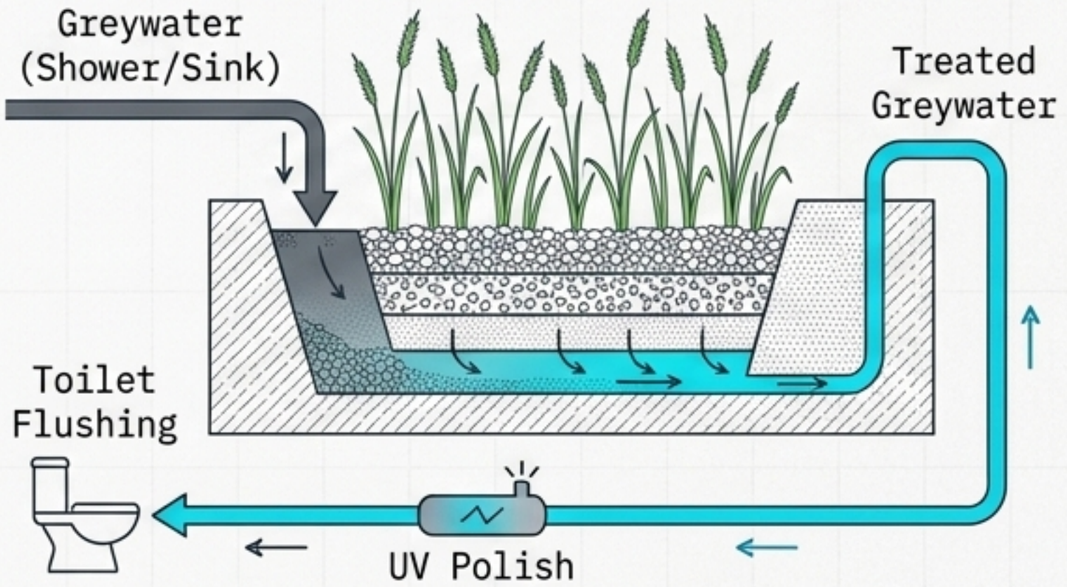


Greywater Recycling (DL 119/2019)

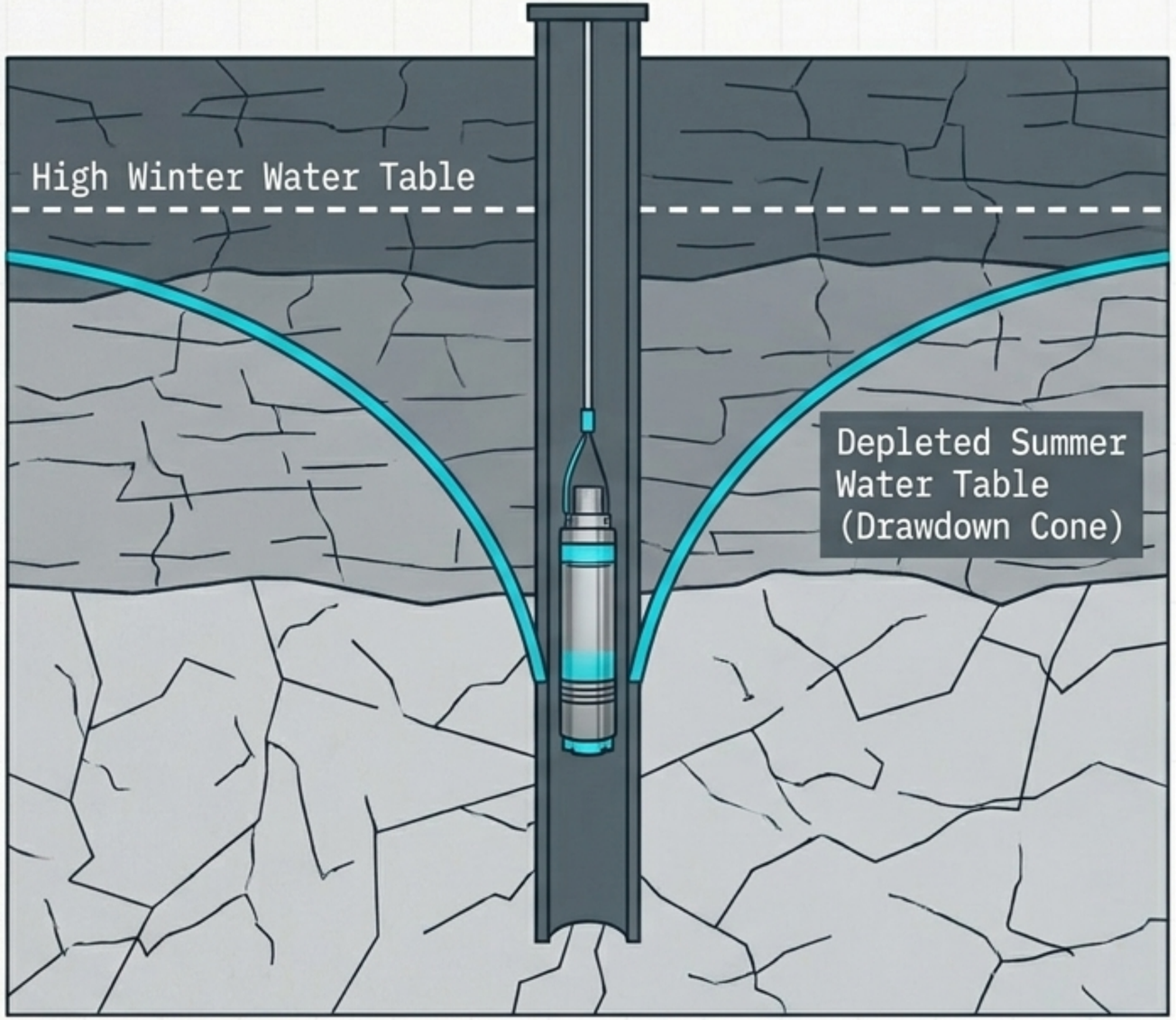
Captures shower/sink water for toilet flushing.

Option A (DIY): Horizontal subsurface flow reed bed (*Phragmites australis*) + UV polish. €500–€1,000.

Option B (Commercial): Aqualoop AL-GW300. ~€5,651. Higher cost, but guarantees compliance with CCDR Norte inspections.



Risk Diagram: Anatomy of a Borehole Failure



The Mechanism

Norte Portugal granite features highly variable fracture patterns. During the 60+ day summer drought, local drawdown cones can rapidly deplete the available column of water in the casing.

The Consequence

If the water level drops below the pump intake, the motor runs dry. Without water to cool it, the €1,000+ submersible pump burns out within minutes.

The Mitigation

Mandatory installation of GSM level sensors in the holding tank + physical low-level cut-off probes strapped directly above the pump in the borehole.

Legal Mandates: DL 69/2023 Drinking Water Standards

The Core Mandate: Private retreats serving guests operate as water supply managers. ASAE strictly enforces compliance.

Zero Tolerance Parameters

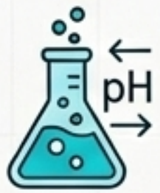
E. coli: 0 CFU/100 mL.

Intestinal enterococci: 0 CFU/100 mL.

Granite Terrain Specifics (Norte PT)

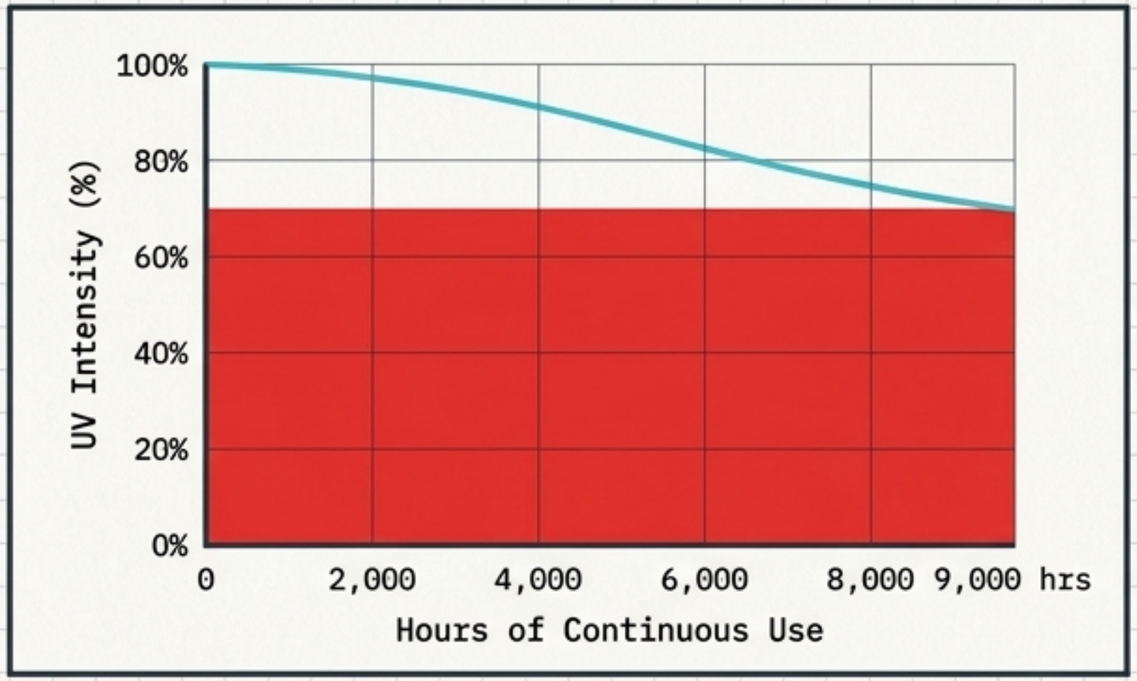
Radon-222: Parametric limit 100 Bq/L. Requires cascade aeration.

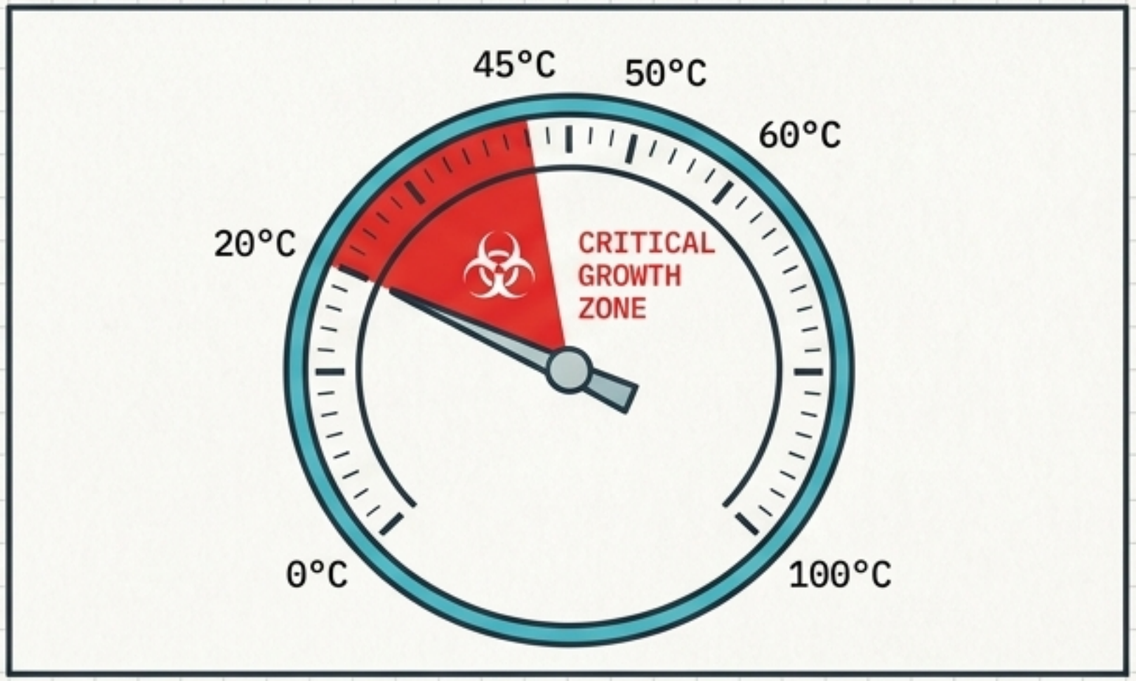
Arsenic: Limit 10 µg/L. Requires RO if exceeded.



pH: Granite water is often highly acidic (5.5–6.5), requiring calcite correction to prevent copper pipe corrosion.

Pathogen Control: Critical Vulnerabilities





Vulnerability 1: UV Lamp Degradation

Intensity drops to ~70% after 9,000 hours (12 months of continuous use), failing to inactivate pathogens despite still glowing blue.

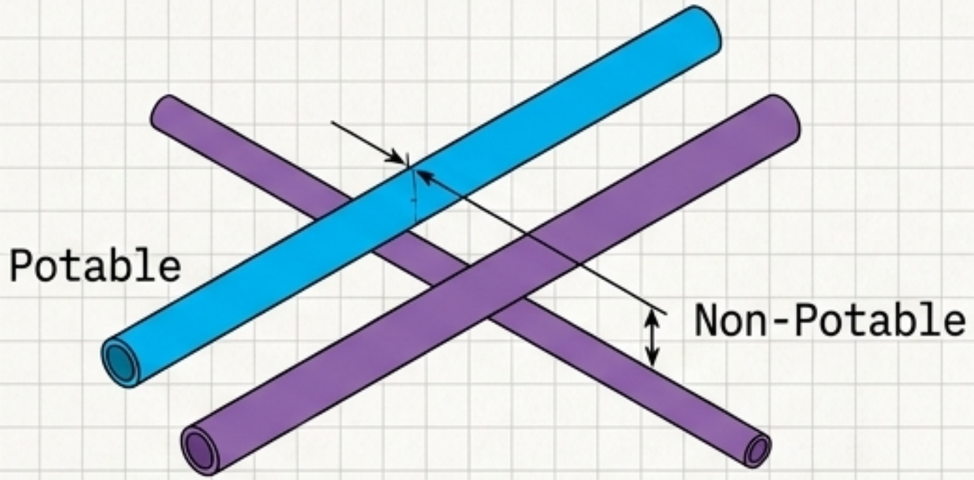
Mitigation: Annual replacement is non-negotiable. Set strict calendar alerts.

Vulnerability 2: Legionella Pneumophila

Regulated under Lei 52/2018. Thrives in stagnant water between 20°C–45°C.

Mitigation: Hot water cylinder minimum 60°C. Distribution ≥50°C. Cold water <20°C. Weekly flush logs for rarely used taps. Formal PPCL plan required.

Network Integrity & Physical Separation



The Rule (DR 23/95): Complete physical independence between potable and non-potable networks.

Visual Coding

All non-potable pipes must be purple MDPE or marked with green/black “ÁGUA NÃO POTÁVEL” tape.

Non-potable taps require warning signs.

Backflow Prevention

- **Type AA Air Gap**: Mains fill pipe discharges above the tank overflow rim. Zero mechanical connection. (Mandatory for mains top-up).
- **Type BA RPZ Valve**: Required if any direct pressurized cross-connection exists. High cost (€200–500) + annual test. Avoid if possible via air gaps.

The Analytical Baseline: Lab Testing Protocol

The Rule: No IPAC-accredited lab publishes public prices. Official collection by lab staff is required for legally valid certification.

Designated Lab: AquaValor (Chaves) or ALS Life Sciences (Porto).

Baseline Commissioning	Before first guests. E. coli, turbidity, nitrates, pH, Radon, Arsenic. (€300–600).
Monthly (High Season)	E. coli, coliforms, pH, turbidity. Send sample within 3h at 2–5°C. (€50–80).
Annual Certification	Full DL 69/2023 compliance panel. (€200–400).
Legionella	Annually or after >7-day closure (ISO 11731 culture).

Operational Reality: Maintenance Rhythm

Weekly Tasks

Flush all rarely-used taps/showers and log the duration (**Legionella control**). Check **UV lamp sensor alarm**.

Monthly Tasks

DPD chlorine residual test (target 0.2–0.6 mg/L). Replace **1-micron Carbon Block filter** (€9.50) if drawing from borehole.

Quarterly/Bi-Annual Tasks

Replace **5-micron sediment filter**. Descale showerheads. Clear First-Flush drain orifices.

Annual Tasks

Replace **UV Lamp** (€68–75). Check accumulator pre-charge. **Tank deep clean (50 mg/L bleach scrub)**. Conduct full **IPAC lab panel**.

Pre-Flight Checklist & Immediate Actions

Immediate Executables (Before Sept 2026)

- Source 2x **food-grade IBCs** via OLX.pt (Fafe/Braga).
- Order 53x **5L bottled water jugs** for the sprint team.
- File APA '**comunicação prévia**' for the rainwater cistern via SILiAmb.

Professional Delegation Matrix (Do Not DIY)

Borehole Drilling: Must be an APA-licensed driller (e.g., Hidro-Cávado) after TURH registration.

Dual-Supply Pipework: Must use a licensed plumber (canalizador certificado).

Legionella PPCL Plan: Must be written by an accredited environmental health consultant.

Final Note: Execution of Level A establishes the beachhead. Strict legal compliance ensures permanent operational security.