



**GLOBAL
STUDENT
OUTREACH**

TECHNICAL SPECIFICATION

Above-Ground Aquaculture / Aquaponics Grow-Out Tank

Solar-Powered • 3.0m Diameter × 1.5m Depth • Single-Unit System

Prepared for

GLOBAL STUDENT OUTREACH

Food Security • Sustainable Livelihoods • Forest & Wildlife Protection • Climate Resilience — Rural Cambodia

Document Rev. 1.0 — August 28, 2023

Target Cost per Unit: USD \$1500

1. Executive Summary

This specification defines a single-unit, solar-powered above-ground aquaculture grow-out tank intended for deployment across Global Student Outreach (GSO) community aquaponics sites in rural Cambodia. The design targets a fully self-contained system — tank, roof, filtration, aeration, and off-grid power — buildable from locally available materials for a target total cost of approximately USD \$1500 per unit.

The system pairs a 3.0m diameter × 1.5m deep grow-out tank (≈ 10,600 liters) with a two-stage external filtration train (sand/stone/media filter tank and a clean water return tank), gravity siphon return, solar-powered aeration and UV sterilization, and a rainwater-harvesting tin roof. Treated water is returned to the grow-out tank through a venturi injector for passive aeration, while excess and solids-laden overflow is diverted to adjoining aquaponics grow beds — turning the tank's own overflow into an irrigation and nutrient input for food production.

This document covers structural, hydraulic, electrical, and construction-phase specifications; a full bill of materials; and system diagrams suitable for field crews and community builders with basic construction, plumbing, and electrical skills.

2. System Overview

Key design parameters at a glance:

Main tank dimensions	3.0 m diameter × 1.5 m depth (≈ 10,600 L / 2,800 US gal capacity)
Tank construction	Galvanized corrugated steel ring wall + 0.75mm HDPE pond liner
Roof	Corrugated tin (galvanized) roof over tank and filtration tanks, on timber/steel posts
Power source	1 × 700W monocrystalline solar panel, MPPT charge controller, 12V ≈85–100Ah battery, 500–600W pure sine inverter
Primary drain	Center-bottom SLO (Solids Lift Overflow) standpipe, routed underground to filter tank
Safety overflow	Secondary overfill drain set below the tank lip, routed to grow beds
Filtration	Two 0.5m diameter cement ring tanks: (1) sand/stone/media filter, (2) clean water holding tank, both cast to the same height as the main tank
Return / aeration	35W 12V transfer pump + 27mm PVC line with venturi injector; inline UV sterilizer
Rainwater capture	Roof-edge gutters and downpipe routed back into the main tank
Target cost	≈ USD \$1500 per unit (materials, media, and labor)

GLOBAL STUDENT OUTREACH | AQUACULTURE TANK SYSTEM – CROSS-SECTION SCHEMATIC (NOT TO SCALE)

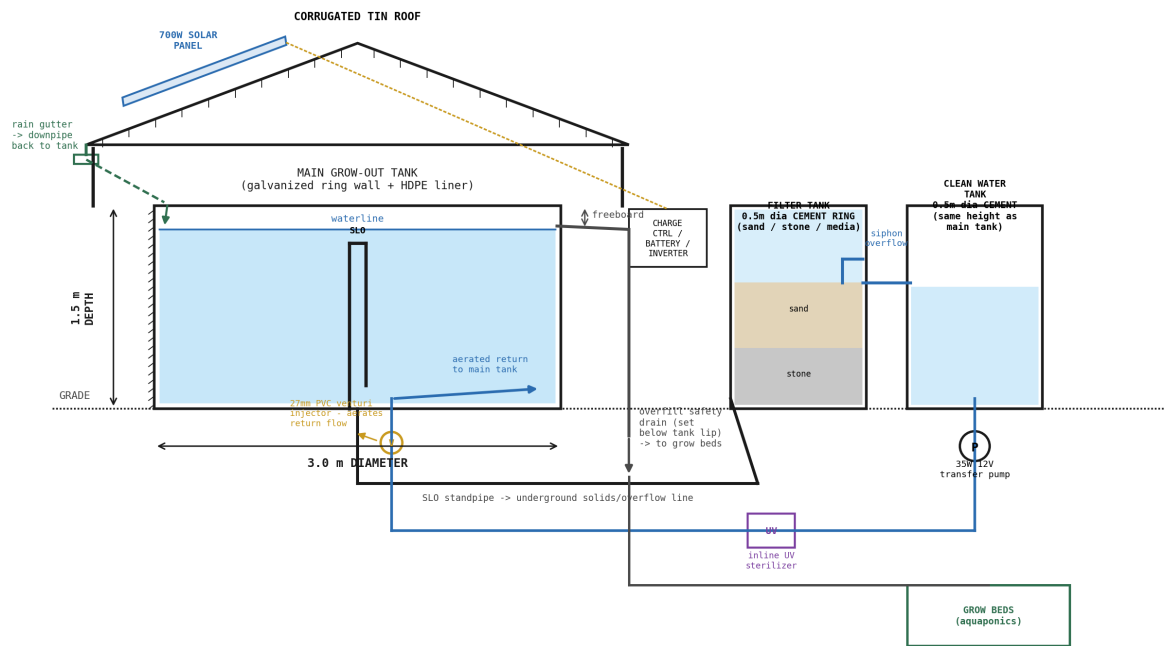


Figure 1 — System cross-section: tank, roof and solar, SLO drain, filtration train, aerated return loop, and grow-bed drainage.

3. Tank Structure Specification

3.1 Main Grow-Out Tank

Diameter	3.0 m
Depth (wall height)	1.5 m
Capacity	≈ 10,600 L (working volume ≈ 9,500–10,000 L allowing freeboard)
Wall material	Galvanized corrugated steel ring, bolted/lapped seams, external bracing hoops at top, mid, and base
Liner	0.75mm heavy-duty HDPE (or equivalent UV-stabilized fish-safe pond liner), draped over wall and secured under a top lip rail
Base	Compacted sand/gravel bed, min. 100mm, laser/string-leveled before liner placement, with a formed center recess for the SLO sump
Freeboard	≈ 150–200mm from working waterline to tank lip to prevent splash-over

3.2 Roof Structure

A corrugated tin roof is erected on timber or steel posts to shade the tank (reducing algae growth and water temperature swings), protect the electrical enclosure, and support the solar panel and rain-gutter system. The roof footprint should extend at least 300–400mm beyond the tank wall on all sides and fully cover both filtration tanks where site layout allows.

- Roof pitch: single or dual-pitch, minimum 10–15° for effective rainwater shedding
- Structure: treated timber or galvanized steel posts set in concrete footings, with purlins on ≈600mm centers
- Roofing: standard corrugated galvanized tin sheeting, overlapped and fastened with rubber-washed roofing screws
- Clearance: minimum 2.0 m from tank lip to roof underside for maintenance access

4. Filtration & Hydraulic System

4.1 Primary Drain — SLO (Solids Lift Overflow)

A center-bottom SLO standpipe assembly is installed at the low point of the main tank. The SLO draws solids-laden water from the tank bottom while maintaining the working water level via its overflow bell, and routes flow underground (≈300mm burial depth) to the external filter tank. This keeps solids export continuous without requiring the tank to be drained.

4.2 Overfill Safety Drain

An independent overfill safety drain is installed with its inlet set below the physical lip of the tank — the same protective principle as an SLO fitting in aquaponics, but purpose-built purely as a fail-safe. If the water level rises above the design waterline (rainfall surge, pump/siphon malfunction, or over-topping from the return line), this drain activates before water can spill over the tank wall. It is piped directly to the grow beds, so any overflow event still delivers nutrient-rich water to production beds rather than being lost.

4.3 External Filter Tank (0.5m cement ring)

Water from the SLO line enters a 0.5m diameter cast cement ring tank layered with mechanical and biological filtration media:

- Bottom layer: coarse stone / gravel (mechanical solids settling and structure)
- Middle layer: washed coarse sand (mechanical filtration)
- Upper layer / voids: bio-media or lava rock (surface area for nitrifying bacteria)

The filter tank is cast to the same finished height as the main grow-out tank so that flow between stages is gravity- and siphon-driven, without needing a pump between the main tank and the filter.

4.4 Siphon Overflow to Clean Water Tank

A siphon overflow fitting carries filtered water from the filter tank into a second 0.5m diameter cement ring tank — the clean water tank — built to the same height. This tank acts as a buffer/sump for the return pump and stabilizes the water level feeding the pump inlet.

4.5 Return Pump, Venturi Aeration & UV Sterilization

Transfer pump	12V DC, 35W, submersible or inline utility/bilge-style pump rated for continuous duty
Return piping	27mm ($\approx 1''$ nominal) PVC pressure pipe
Aeration method	Venturi injector fitted inline on the 27mm return line — draws atmospheric air into the water stream as it is pumped back to the main tank, dissolving oxygen without a separate air pump
Alternative/backup aeration	Elevated discharge option: return line can be routed to a high point and allowed to free-fall back into the tank surface, adding a secondary splash-aeration path if the venturi is removed for cleaning
UV sterilization	Inline UV sterilizer, $\approx 15W$, plumbed into the return line ahead of the venturi to reduce pathogen and algae load in recirculated water

5. Electrical & Solar Power System

The system is designed to run entirely off-grid on solar power, sized around the two continuous electrical loads (35W transfer pump, 15W UV sterilizer) plus headroom for lighting or future instrumentation.

Solar panel	1 × 700W monocrystalline panel, roof-mounted at an angle optimized for local latitude
Charge controller	MPPT, 40–60A rated, 12/24V auto-sensing — sized for panel I_{sc} with a safety margin
Battery	12V lead-acid deep-cycle or heavy-duty car battery, ≈ 85–100Ah, housed in a ventilated weatherproof enclosure
Inverter	Pure sine wave, 500–600W continuous rating, sized to run the AC-side UV sterilizer and any auxiliary AC tools
DC distribution	Fused/breaker-protected 12V bus feeding the transfer pump directly (no inverter loss on the largest continuous load)
Estimated daily load	≈ 35W (pump) + 15–20W (UV) run near-continuously ≈ 1.2–1.3 kWh/day — comfortably within a 700W panel's daily yield in Cambodia's solar resource (≈ 4.5–5.5 peak sun-hours) after system losses

GLOBAL STUDENT OUTREACH | ELECTRICAL / SOLAR POWER BLOCK DIAGRAM

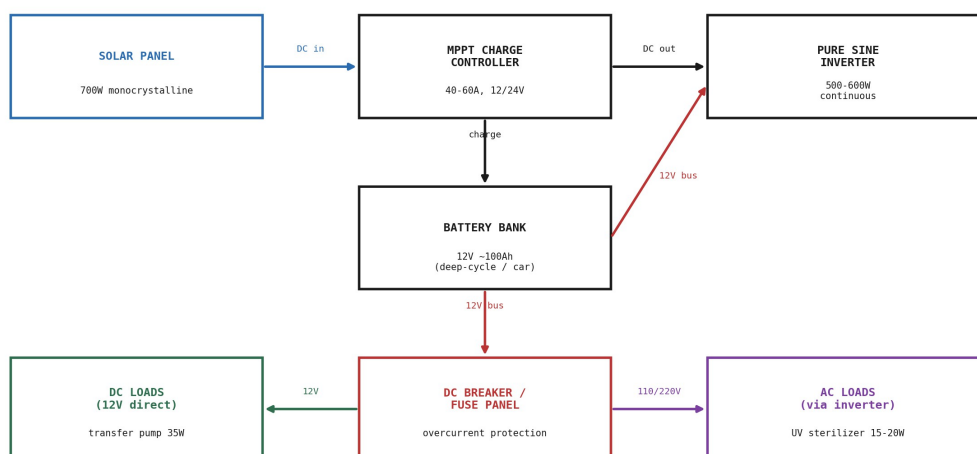


Figure 2 — Electrical / solar power block diagram.

Design notes: keep the transfer pump on the 12V DC bus directly rather than through the inverter to avoid unnecessary conversion losses on the system's largest continuous load. Reserve inverter capacity for the UV sterilizer and any future AC accessories (e.g., a backup air pump). All wiring should be sized for the 12V bus current (higher amperage than an equivalent 24/48V system) and protected with appropriately rated breakers or fuses at the battery and at each load.

6. Rainwater Capture

Gutters are installed along the low edge(s) of the tin roof and pitched to a downpipe that discharges directly back into the main tank, supplementing evaporative losses and reducing dependence on hauled or well water for topping

up the system. Gutter capacity should be sized for the local peak rainfall intensity and the full roof catchment area; a leaf/debris screen at the gutter outlet is recommended to keep organic debris out of the tank.

7. Site Layout

GLOBAL STUDENT OUTREACH | SITE LAYOUT PLAN – TOP VIEW (NOT TO SCALE)

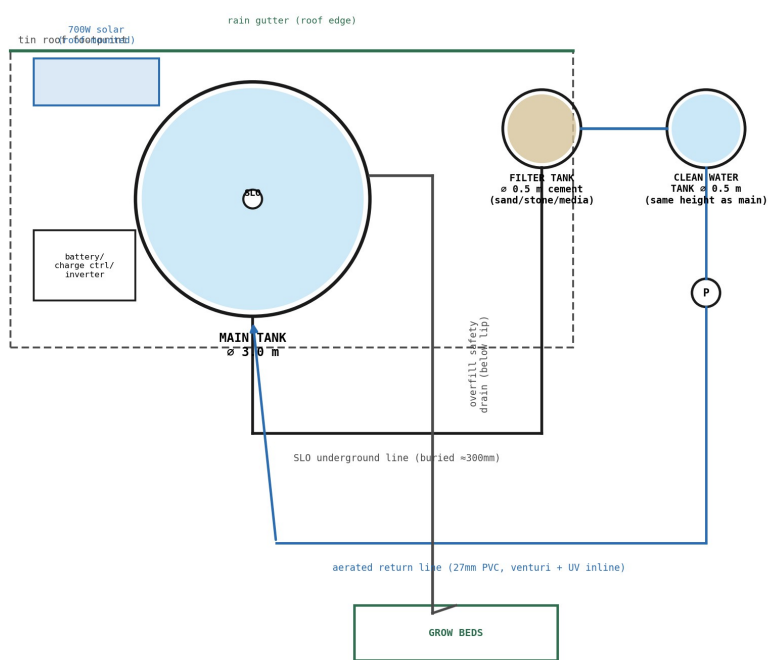


Figure 3 — Site layout plan (top view): main tank, filtration train, electrical enclosure, and grow-bed drainage.

8. Construction / Build-Out Phasing

The build is sequenced so that civil and cement work (which requires cure time) happens early, while electrical and finishing work happens toward the end. A single crew of 2–3 people with basic construction, plumbing, and electrical skills can complete one unit in approximately 3–4 weeks including biological cycling time before the tank is stocked.

Phase	Scope of Work	Duration
Phase 0 — Site Selection & Prep	Confirm level, well-draining site near existing or planned grow beds; clear vegetation; establish access for materials and water source; verify solar orientation (unobstructed southern/northern exposure per hemisphere).	1–2 days
Phase 1 — Foundation & Tank Shell	Compact and level a sand/gravel base for the 3.0m tank footprint; erect galvanized corrugated ring wall with bracing; install HDPE liner; form and cast the center SLO sump recess.	3–4 days
Phase 2 — Filtration Tanks & Underground Plumbing	Cast the two 0.5m cement ring tanks (filter tank and clean water tank) at the same finished height as the main tank; trench and lay the underground SLO line (≈300mm depth) connecting the main tank sump to the filter tank; install bulkhead fittings.	3–5 days (incl. cement cure)
Phase 3 — Roof & Solar Structure	Erect posts and purlins; install corrugated tin roof sheeting sized to fully shade the tank and filtration tanks; mount rain gutter along the low roof edge with downpipe routed back into the main tank.	2–3 days
Phase 4 — Electrical Installation	Mount the 700W solar panel on the roof slope; install MPPT charge controller, battery, breaker panel, and inverter in a weatherproof enclosure; run 12V DC wiring to the pump location and AC wiring to the UV sterilizer.	1–2 days
Phase 5 — Hydraulic Fit-Out	Install the SLO standpipe/overflow fitting in the main tank; set the overflow safety-drain standpipe below the tank lip and route it to the grow-bed line; plumb the siphon overflow from filter tank to clean water tank; install the 35W transfer pump, 27mm PVC return line, and venturi injector; plumb the inline UV sterilizer into the return line.	2–3 days
Phase 6 — Grow Bed Integration	Connect the overflow safety-drain and any designated grow-bed offtake to the aquaponics grow beds; confirm gravity fall and flow control valves.	1 day
Phase 7 — Commissioning & Cycling	Fill tank, verify all drains, siphon break, and pump/venturi operation; verify solar charge/discharge performance under load; begin biological cycling (ammonia/nitrite/nitrate monitoring) before stocking fish.	2–4 weeks (biological cycle)
Phase 8 — Handover & Training	Walk local operators/students through daily checks, solar system monitoring, filter maintenance, and emergency drain procedures; hand over as-built drawings and this specification.	1 day

9. Bill of Materials & Cost Summary

Costs below are planning-level estimates in USD, based on materials sourced locally in Cambodia where practical (cement, sand, stone, timber, tin roofing) and imported/regional sourcing for solar and electrical components. Actual costs will vary by province, supplier, and exchange rate.

A. Tank Structure & Roof

Item	Qty	Unit (USD)	Total (USD)
HDPE pond liner, 0.75mm heavy-duty (3.0m dia × 1.5m depth + overlap)	1	180	180
Galvanized corrugated ring wall + steel bracing hoops	1 set	190	190
Corrugated tin roof sheeting + timber/steel posts & purlins	1 set	150	150
Site preparation & compacted sand/gravel base	1	35	35
Subtotal — A. Tank Structure & Roof			\$555

B. Filtration System (2× cement ring tanks)

Item	Qty	Unit (USD)	Total (USD)
Cement ring tank fabrication (mold, cement, rebar, labor) — 0.5m dia × 2	2	55	110
Filter media — washed sand, gravel/stone, bio-media	1 set	25	25
SLO fitting, 110mm bulkhead fittings, uPVC underground line (≈6m)	1 set	55	55
Subtotal — B. Filtration System (2× cement ring tanks)			\$190

C. Solar / Electrical System

Item	Qty	Unit (USD)	Total (USD)
Solar panel, 700W monocrystalline	1	170	170
MPPT charge controller, 40–60A 12/24V	1	40	40
Battery, 12V ~100Ah (deep-cycle / heavy-duty car battery)	1	75	75
Pure sine wave inverter, 500–600W continuous	1	50	50
Inline UV sterilizer, 15W	1	30	30
Water transfer pump, 12V DC, 35W	1	22	22
Wiring, breakers, junction box, panel mounting hardware	1 set	35	35
Subtotal — C. Solar / Electrical System			\$422

D. Plumbing, Aeration & Drainage

Item	Qty	Unit (USD)	Total (USD)
27mm PVC pipe, venturi injector fitting, unions & elbows	1 set	30	30
Overfill safety-drain standpipe assembly (set below tank lip)	1	20	20
Rain gutter + downpipe, aluminum (≈9m) with tank return	1 set	35	35
Grow-bed distribution manifold + ball valves	1 set	25	25
Subtotal — D. Plumbing, Aeration & Drainage			\$110

E. Labor & Contingency

Item	Qty	Unit (USD)	Total (USD)
Skilled labor — plumbing & electrical installation	1	140	140
Unskilled labor — excavation, tank assembly, cement work	1	60	60
Contingency / miscellaneous hardware ($\approx 2\%$)	1	23	23
Subtotal — E. Labor & Contingency			\$223

TOTAL ESTIMATED COST PER UNIT: USD \$1500

Cost-reduction notes: labor cost can be reduced further where GSO volunteers, students, or community members contribute unskilled labor (excavation, cement mixing, tank assembly), which is not uncommon in similar rural builds. Bulk procurement of solar/electrical components across multiple units (batch ordering panels, controllers, pumps) is likely to reduce per-unit electrical costs by 10–15%.

10. Operations & Maintenance

10.1 Routine Checks

- Daily: visually confirm water level at the SLO overflow line, listen/observe pump and venturi operation, check battery state of charge indicator.
- Weekly: inspect gutter screens for debris, check filter tank surface for excessive solids buildup, test UV sterilizer sleeve for fouling.
- Monthly: backwash or rinse the top layer of filter media, inspect all pipe joints and the overfill safety drain for blockage, clean solar panel surface.
- Quarterly: full inspection of liner for wear, battery terminal cleaning and load test, venturi injector disassembly and clean.

10.2 Water Quality Monitoring

- Test ammonia, nitrite, and nitrate at minimum weekly once stocked, more frequently during initial biological cycling.
- Monitor dissolved oxygen periodically to confirm the venturi aeration loop is maintaining adequate DO, particularly at pre-dawn low points.

11. Safety & Site Considerations

- Electrical enclosure must be weatherproof (IP65 or better) and elevated above expected flood/splash lines.
- All 12V wiring runs should be adequately sized and fused to prevent overheating given the higher current draw of a 12V system.
- The overfill safety drain must always be installed and tested before the tank is filled — this is the primary defense against structural overtopping and site flooding.
- UV sterilizer units emit UV-C light; sleeves and housings must remain intact and sealed — never look directly at an unshielded UV lamp.
- Underground SLO and return lines should be marked at the surface (paint, stakes, or as-built drawing on file) to prevent accidental damage during future site work.

12. Revision & Contact

This is a planning-stage specification (Rev. 1.0) intended to guide prototype construction of the first unit. Dimensions, costs, and component selections should be validated against locally available materials and updated after the first build before scaling to additional units across GSO sites.

Global Student Outreach — Food Security, Sustainable Livelihoods, Forest & Wildlife Protection, and Climate Resilience in Rural Cambodia.