

Sustainable Wastewater Solutions for Healthcare Facilities

 **Kampong Tralach District, Kampong Chhnang, Cambodia**

2025 South East Water Innovators
Solve Challenge
Melbourne, Australia
22/08/2025

Introduction

Healthcare facilities in Kampong Tralach are vulnerable to climate change problems such as flooding, monsoon seasons causing high ground water, unreliable power (frequent outages), drought, and water security (groundwater contamination). About 5 health centres lack adequate septic systems, leading to seepage and contamination of groundwater, which increases the health risks to both personnel and patients. This presentation outlines the design of a climate resilient septic system to be piloted in Kampong Tralach.

Key Climate Related Risks to Healthcare Facilities in Kampong Tralach



1. Flooding



2. High Groundwater



3. Energy



4. Water Security



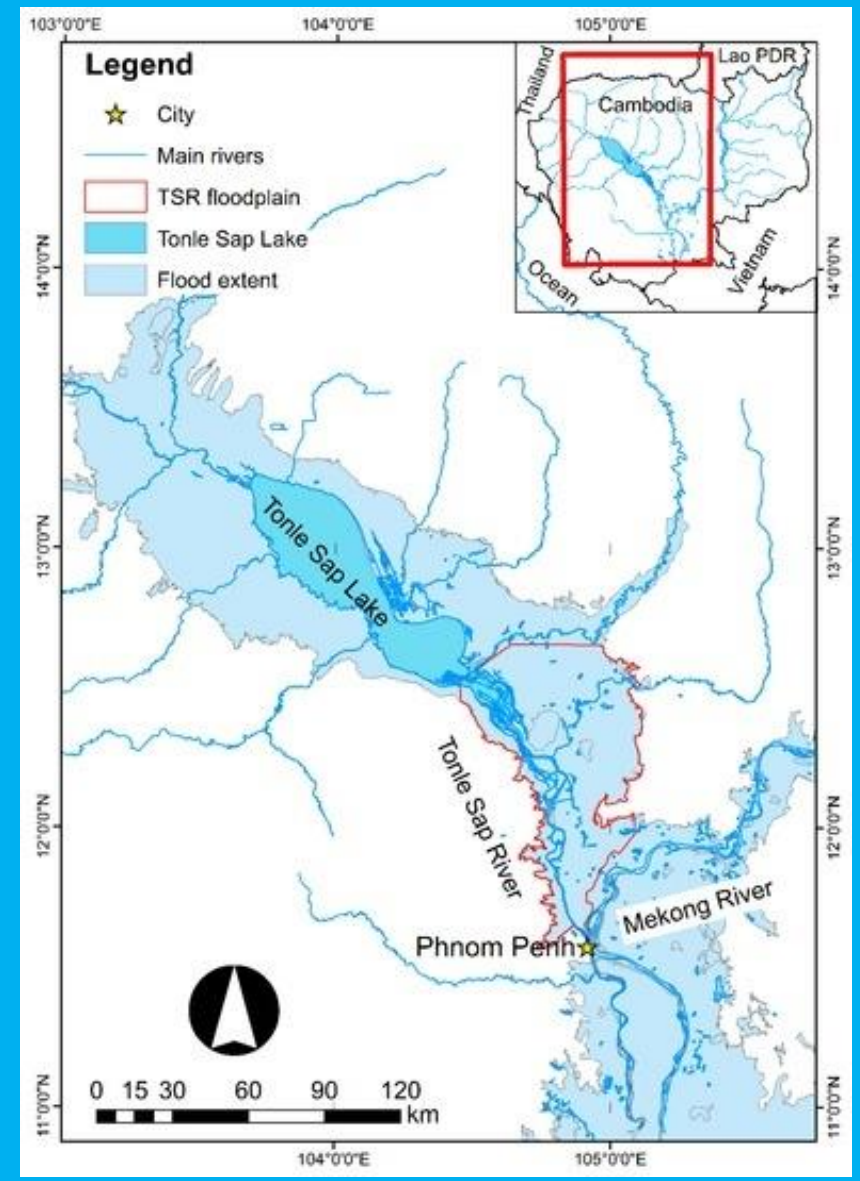
5. Drought

Cambodia is home to over 17 million people and is classified as a low-middle income country (LMIC). In the face of climate change, strengthening WASH facilities is key to improving public health and sustainable development across the country.

Kampong Tralach is a district in the south east of Kampong Chhnang province, in central Cambodia.

The **Tonle Sap** Lake is connected to the Mekong River via the Tonle Sap River and plays an important part of Cambodia's economy through fishing activities.

Flooding occurs **annually**, with news reports in 2023 stating that areas of Kampong Tralach had submerged houses after 3 days of rainfall [4]



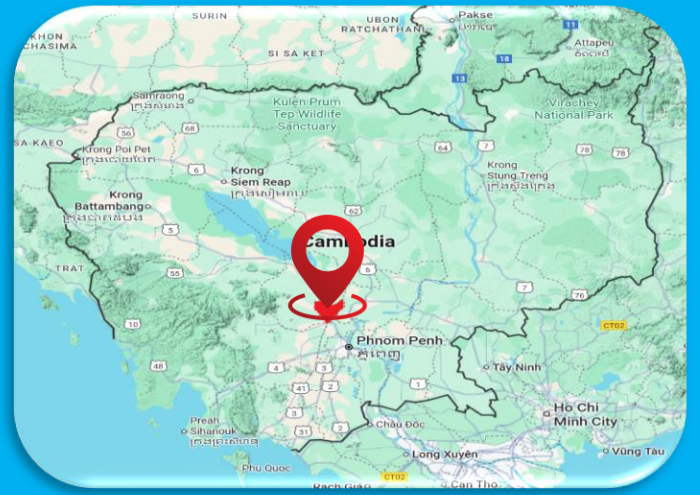
12th most vulnerable country to climate change by the Global Climate Risk Index [1]

80% of the population in Cambodia live in rural areas [1]

72% of the provinces in Cambodia experienced severe drought in 2015-2016, impacting 2.5 million people [1]

71% of people in rural Cambodia have access to basic sanitation in 2022, increased from 46% in 2015 [2]

151 out of 193 countries for the Human Development Index [3]



Population of Kampong Tralach: 99,356 [5]

85% of Families' main occupation in Kampong Tralach is Agriculture [6]

In the dry season, 60% of families get drinking water from clean/safe sources and 40% get drinking water from unsafe sources [6]

Health Care Centres in Kampong Tralach

There are 11 Health Centres in Kampong Tralach [6]

Health care facilities have 65 clients daily with approximately 15 kL/day wastewater produced

Wastewater is primarily domestic, with high pathogen loads, disinfectants, pharmaceuticals, and trace heavy metals

Flood Extent Map for the Tonle Sap River showing Kampong Tralach falling within the flood extent [7]

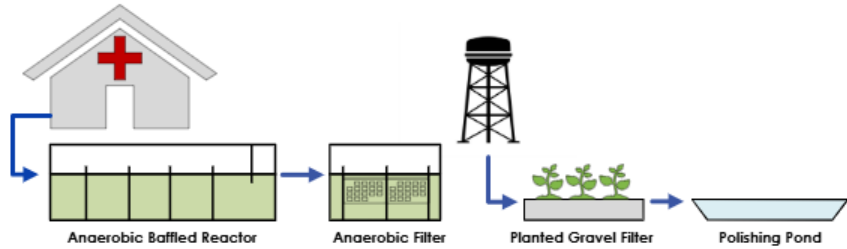
Design Options

Option 1

Decentralised Wastewater Treatment Systems (DEWATS)

An on-site, off-grid treatment solution which collects, treats and disposes of wastewater from the vicinity, ideal for areas where centralized systems are impractical.

DECENTRALISED WATER TREATMENT SYSTEM

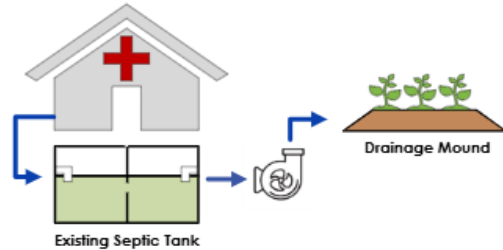


Option 2

Reinforced below ground septic tank with drainage mound

Existing Septic tank is reinforced with HDPE liner, and a pump well is installed. Pump pushes wastewater to a drainage mound which provides treatment through above-ground soil filtration.

REINFORCED SEPTIC TANK TO DRAINAGE MOUND

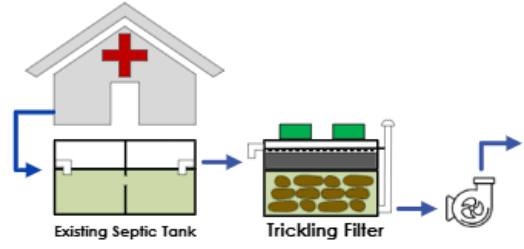


Option 3

Retrofit existing tank to BIOROCK advanced treatment

Upgrading existing septic tank system by adding on a BIOROCK system, providing an on-site treatment plant with a trickling filter. Treated wastewater is pumped out and released into the environment.

BIOROCK ADVANCED TREATMENT

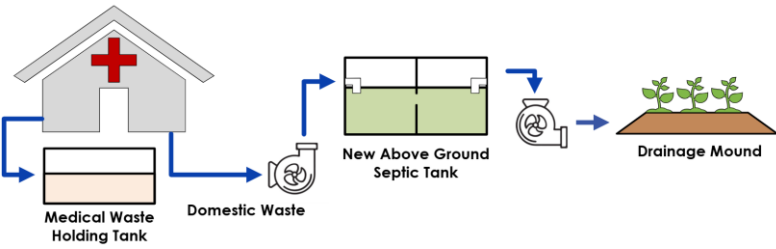


Option 4a

Above ground septic tank & constructed drainage mound

Practical and safe alternative to subsurface septic tanks which avoids groundwater intrusion and reduces contamination risk. Subsurface pump moves wastewater to a drainage mound which allows treatment through above-ground soil filtration. This option also segregates medical waste in a holding tank.

ABOVE GROUND SEPTIC TANK TO DRAINAGE MOUND

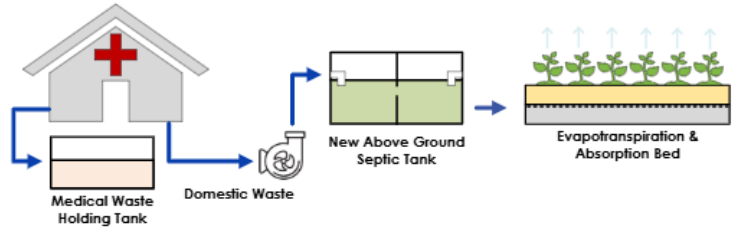


Option 4b

Above ground septic tank & evapotranspiration bed

Practical and safe alternative to subsurface septic tanks which avoids groundwater intrusion and reduces contamination risk. Subsurface pump moves wastewater to an evapotranspiration bed, which is an on-site treatment and disposal system. This option also segregates medical waste in a holding tank.

ABOVE GROUND SEPTIC TANK TO EVAPOTRANSPIRATION BED



Multi-Criteria Analysis of Options

MCA Criteria & Weighting

Cost	Nominal Cost and Net Present Value results of each option	15%
Constructability	Project design risk and assumptions. Overall, practicality of implementation	15%
Operability	Ability to reliably operate and maintain. Complexity and robustness	20%
Future Proofing	Ability of the solution to meet and exceed its useful life taking into consideration climate resilience	20%
Community Impact	Social impact on local community during construction and operation, including odour/noise. Customer satisfaction with the service	10%
Safety	Impact on safety & wellbeing within the employee, customer, suppliers and other stakeholder population.	10%
Environmental Risk	Potential for environmental risks or incident during construction & operations. Pollution and waste impacts. Robustness in meeting environmental obligations and targets	10%

Scoring

Very Much Better	4
Much Better	3
Moderately Better	2
Little Better	1
No Change	0
Little Worse	-1
Moderately Worse	-2
Much Worse	-3
Very Much Worse	-4

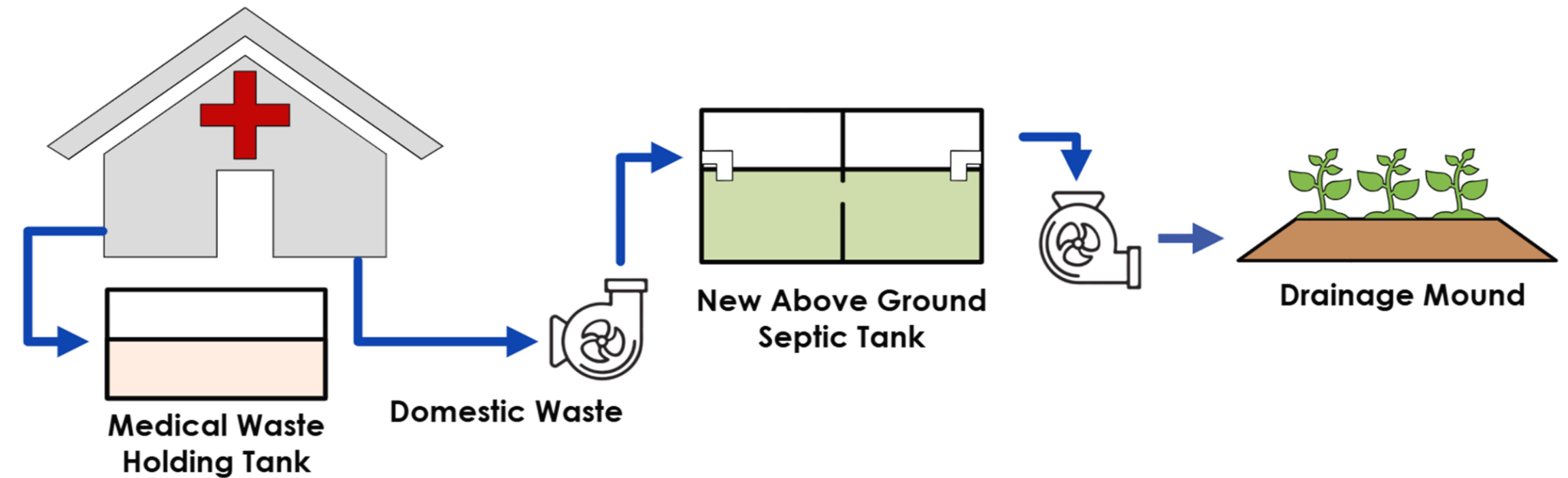
	Base Case Current conditions	Option 1 DEWATS	Option 2 Reinforced below ground septic tank with drainage mound	Option 3 Retrofit existing tank to BIOROCK advanced treatment	Option 4a Above ground septic tank to constructed drainage mound	Option 4b Above ground septic tank to evapotranspiration adsorption bed
Cost	0	-3	-1	-2	-3	-3
Constructability	0	-4	-2	-1	-3	-3
Operability	0	-3	-1	-2	-1	-2
Future Proofing	0	-1	1	1	3	1
Community Impact - Local context and cultural awareness	0	-1	1	1	3	2
Safety	0	2	1	1	3	2
Environmental Risk	0	1	1	1	3	2
Final Score	0	-1.65	-0.15	-0.35	0.4	-0.5

Solution

Aboveground Septic Tank System with a Drainage Mound and Medical Waste Segregation

Part 1: Aboveground Septic System

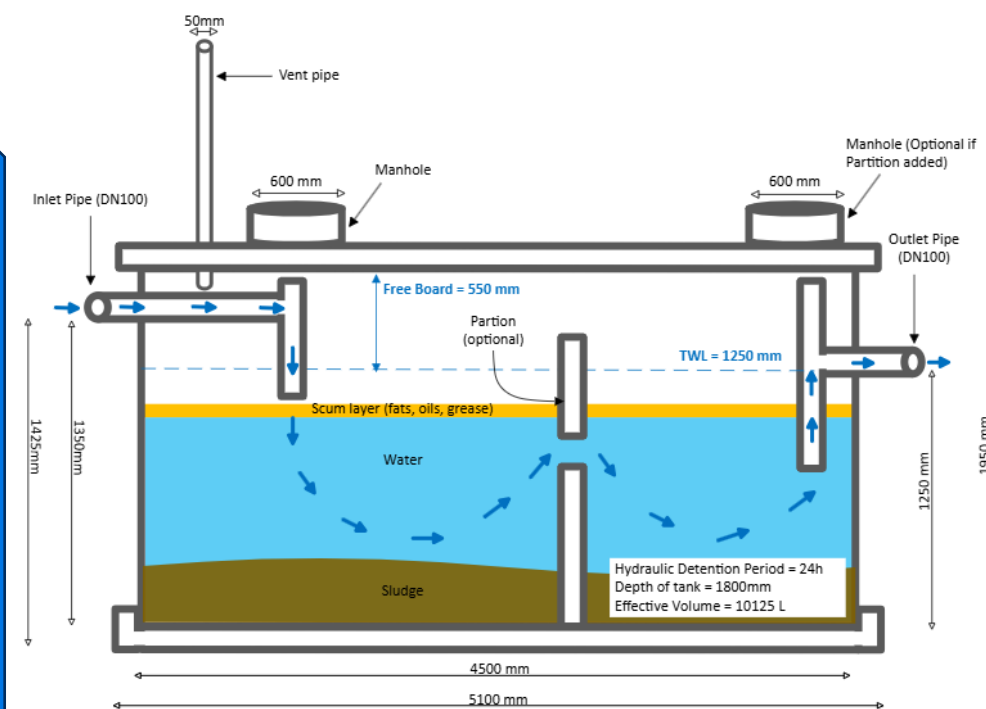
ABOVE GROUND SEPTIC TANK TO DRAINAGE MOUND



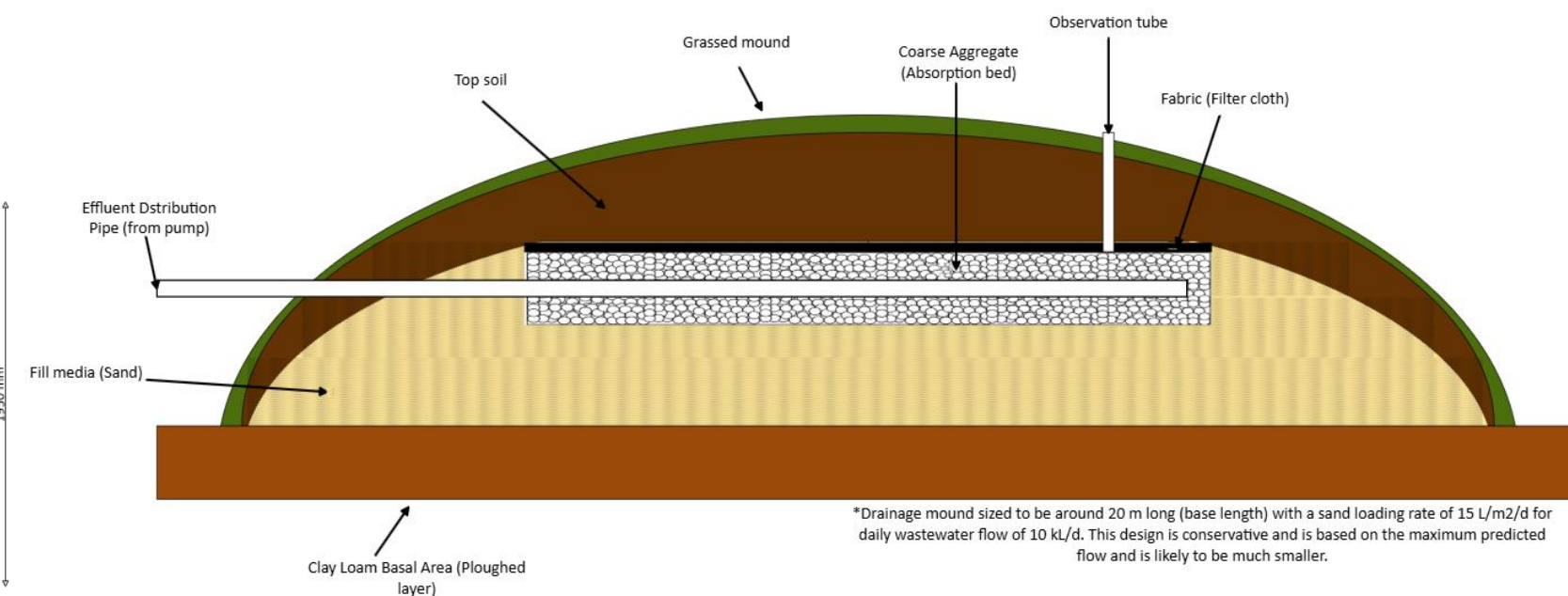
An above ground septic tank with a drainage mound offers a practical and safer alternative to conventional subsurface septic tanks. The aboveground tanks are sealed, raised structures which avoid groundwater intrusion and avoids excess excavation, saving costs for rural facilities.

Key Benefits

- Protects groundwater and reduces contamination risk to the community and healthcare personnel.
- Suited for areas like Kampong Tralach which experiences annual flooding, high water table, and poor soil absorption.
- Cost effective alternative to excavation required for subsurface tanks.
- Low-maintenance and locally adaptable.
- Suitable for hard soil areas.



Aboveground septic tank with a design capacity of 10 kL/d domestic wastewater for medium-larger Health Care Facilities (about 65 clients).

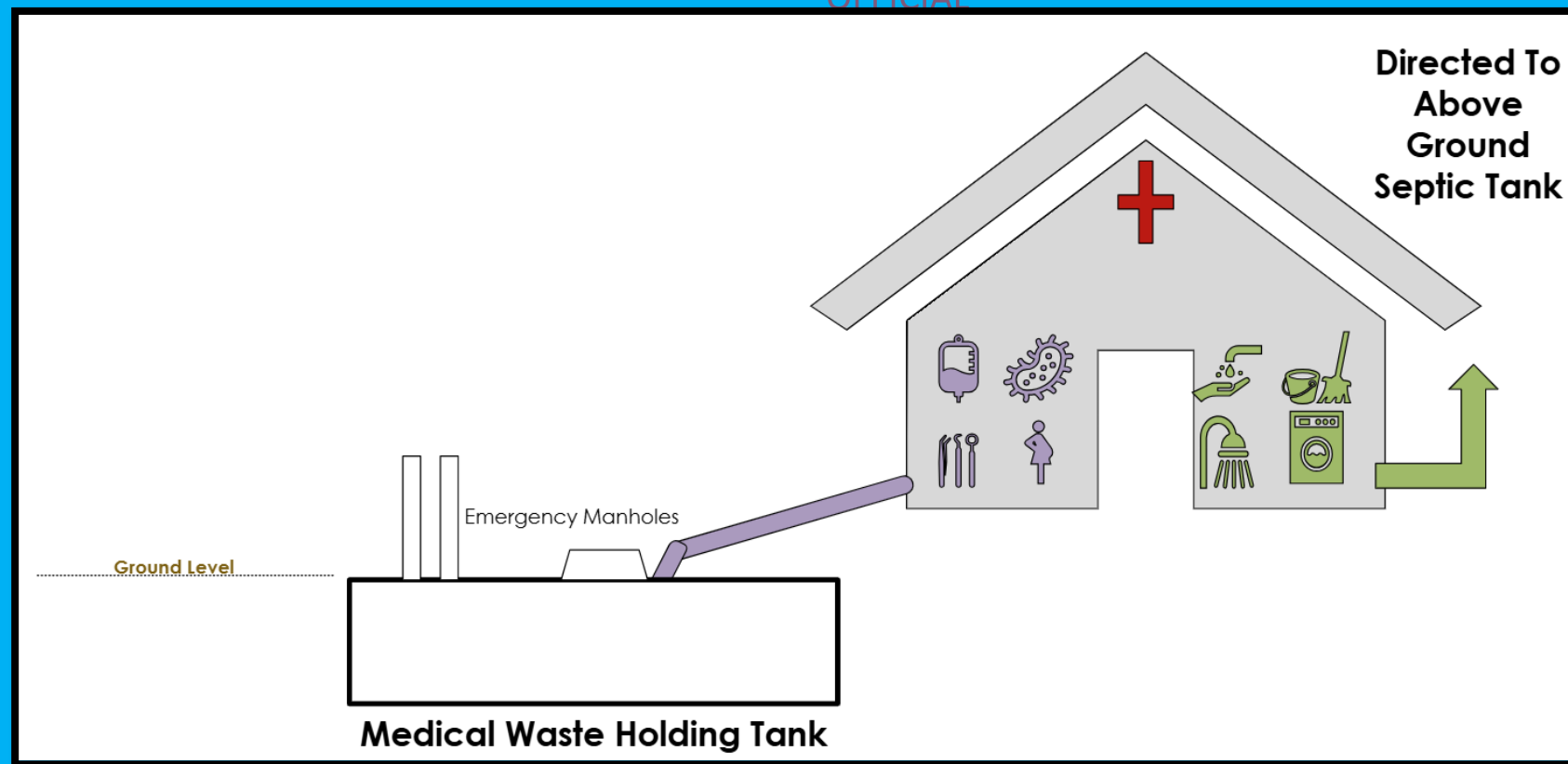


Drainage mound provides an alternative to conventional drain fields which can become waterlogged due to high water table, seasonal flooding, and low drainage clay rich soil (clayey loams are common in Kampong Tralach). Mounds can be large, which can limit its use in land constricted areas, however using high drainage sand like river sand can significantly decrease the size of the mound required.

Solution

Aboveground Septic Tank System with a Drainage Mound and Medical Waste Segregation

Part 2: Waste Segregation



Design

- Sealed holding tank – preventing medical wastewater escaping during flooding events.
- 50 m³ sized tank installed at medical facility, given size of free space area, multiple 50 m³ tanks can be installed.
- Allowing max of 5 m³ medical wastewater discharge per day.
- Installed underground – gravity fed system – not reliant on pumps

Transportation

- Waste should be transported to treatment facility on a bi-weekly basis where further incineration, and disinfectant processes are undergone. Medical waste collection and treatment could be handled by the Medical Waste Management Unit (MWMU) of Red Cross Cambodia. Ultimately providing transportation, treatment and final disposal services to the health care facility in the city through service contracts with the HCFs [9].
- Large scale incinerators installed in nearby districts (Kampong Chhang provinces) may also provide medical waste services [10].

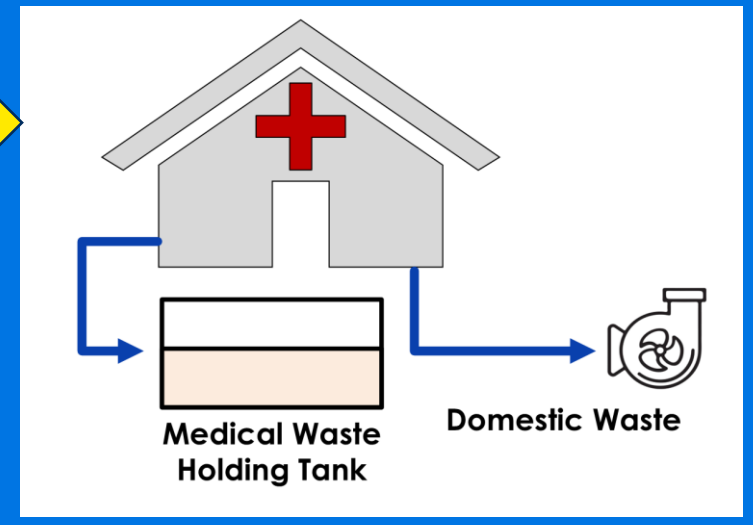
Impact of Medical Waste

There is evidence to show that, the toxicity of medical waste can be up to **5-15 times greater** than urban effluent. Additionally, medical wastewater may introduce spread of **antibiotic-resistant bacteria** into the environment [8]

There is a need to reduce the public health risk by avoiding medical effluent being discharged into the environment.

Solution

Segregate medical waste into holding tank for removal and transportation



What Type of Waste is Segregated?

- Delivery and minor surgical room waste
- This waste may contain blood, amniotic fluid and other fluids from childbirth
- Waste from other minor wound or surgical procedure.
- Waste water from cleaning medical surgical tools

What Type of Waste is NOT Segregated?

- Discharges from kitchens, laundries and toilets from normal domestic discharge

System Function

Holding Tank

Gravity fed Medical Wastewater segregated holding tank (based on 5 m³/day wastewater, tank size 50 m³), where contents are pumped out and trucked to a treatment facility where further incineration and disinfectant processes are undergone.



Septic Tank

Above ground septic tank for Domestic Wastewater. 10,125 L effective volume and 24h hydraulic detention period (baffle optional). Wastewater enters, scum floats to the top, solids settle to the bottom, and effluent sits in the middle, which exits through the effluent pipe.



Drainage Mound

Above ground soil filtration where the effluent is pumped into the absorption bed (with coarse gravel) and distributes through the effluent piping. Effluent pumped in small quantities to facilities trickling down the mound (sand fill).



Pump 1

Sewage-grade pump which moves 60 L/min @ 3.3m TDH, ~0.25 kW, dosing 400 L/run (25 runs/day; ~6 min 40 sec/run; ~2.8 h/day; ~0.70 kWh/day) and sends pulses to the septic tank. Float controlled (LOW/HIGH) with check + isolation valves.



Pump 2

Effluent pump which moves 50 L/min @ ~2.6m TDH, ~0.18kW, dosing 400 L/run (25 runs/day; ~8 min/run; ~3.3 h/day; ~0.60 kWh/day). Lifts effluent from a small post-septic chamber to the drainage mound. Float controlled (LOW/HIGH) with check + isolation valves.



Solar PV + Battery

Solar-charged LiFePO₄ battery powers the pumps automatically at night/outages, then PV refills the battery by day. (2×115 W (230W)→LiFePO₄ 12.8 V 150 Ah) covering ~0.65 kWh/night; in a full-day outage the battery delivers ~1.3 kWh AC and PV restores ~1.0 kWh/day.

Climate Resilient Features

Climate Issue	System Benefit
Drought	Aboveground equipment results in the system being resistant to the damaging effects of dry/hardened clay soils cracking.
Power Outage	<p>In rural Cambodia, power outages of several hours are not uncommon. The pump wells have a holding capacity of 4 hours to prevent any sewage backups.</p> <p>When the grid drops, a solar-charged battery automatically runs the pumps. Grid is primary used the rest of the time, so service continues without a genset.</p> <p>Gear sits on a flood-safe plinth and clinic staff do simple checks</p>
Flood	The aboveground drainage mound allows for effluent to continue to be pumped out during a flood as the ground may be saturated, but the mound wouldn't be.
High Ground Water (Monsoon Season)	<p>With high ground water, any subsurface equipment (if the groundwater level is high enough) would float and any fixed piping/structures would move and be damaged.</p> <p>This system performs well during the monsoon season as the system is above ground.</p> <p>With high ground water, the ground is saturated with water. Drainage mounds are not impacted by this and can still accept effluent.</p>

Maintenance

Daily

Pump Check (5 minutes)

- **Control light:** Green = OK, Red = Alarm
- **Hour meter:** Confirm it has advanced since the last check
- **Wet-well lid (do not lean in):** Open slightly and check water level + inlet rag buildup

Quarterly

Pump checks: 20–30 mins

- Rinse rags and grit from the wet-well surface using a bucket and scoop

Solar PV: 10 mins

- Wash panels with clean water and a soft brush (no soap)
- Confirm PV switch is ON and locked
- Ensure cables are tidy and free from chew marks

Battery checks: 10–15 mins

- Confirm Eco/Standby mode is active (low idle draw when pumps are idle)

Monthly

Medical Waste Pump Out (Bi-weekly)

- Ensure medical waste pump-out is completed every two weeks.

Solar PV Checks – 5 mins

- Verify panels are not shaded by new branches or covered in dust/mud. Confirm panel frames are secure and intact.

Battery Checks – 5 mins

- Check state of charge (SOC) is above ~50% and no warning icon is displayed.
- Cabinet should feel warm (acceptable), but not hot. If hot, provide shade or ventilation to the cabinet.

Yearly

Biannual septic tank pump out

Pump service completed by technician

Battery check: (15-20mins)

- Visual on battery lugs (no green/white crust), DC fuses intact, labels legible

Training

- **Train 4-6 healthcare staff** to carry out the maintenance tasks
- **Use a buddy system:** two designated staff members sign off the log each month
- **Keep a record** by sharing photos of the log via WhatsApp.

Education

- **Provide training for all staff** so they understand proper waste disposal practices, ensuring the system functions well and reducing pollution.
- **Do not flush non-biodegradable items** such as a diapers, sanitary products, cigarette butts, or cooking grease down the drain.
- **Use a sink strainer** to capture food scraps and other debris
- **Never dispose of chemical or medical waste** through the drainage system.

Community Impact & Engagement

Community Benefits

Prevention of groundwater contamination (areas of Kampong Tralach use groundwater wells for farm irrigation and drinking).

Protection of community and healthcare personnel health (prevention of septage leakage and segregation of hazardous medical waste).

Improved liveability through clean surface water and decreased odour impacts.

Improved water effluent quality through medical waste segregation.

Versatile drainage mound design allows for tailored solutions for other health care facilities

Costs

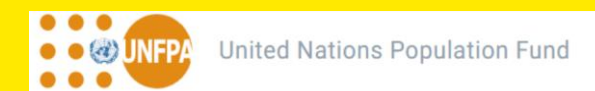
Septic Tank	\$5,000
Holding Tank	\$25,000
Piping	\$1,000
Pumps	\$1,815
Drainage Mound	\$15,000
Solar PV	\$383
Battery + Inverter	\$4,667
Excavation	\$3,000
Labour	Free
Total	\$55,865

*Labour is assumed to be provided by WaterAid

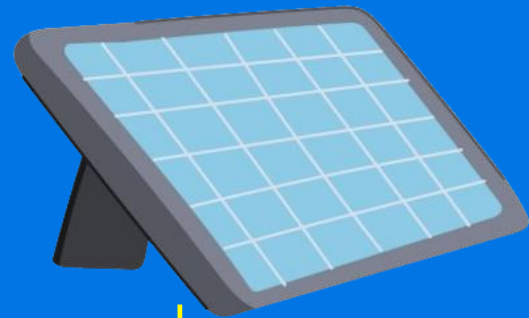
Funding

There are several avenues for the funding of this infrastructure, including international development agencies, NGOs, nonprofits and national programs. Loans, developmental assistance and strategic public-private partnerships (PPP) are key strategies to address the funding gap [11].

For technical, financial and policy support related specifically to WASH implementation in healthcare facilities, the Cambodia Health Equity and Quality Improvement Project (H-EQIP), the Second Health Sector Support Program (HSSP2), URC-CHS, the World Health Organisation (WHO) and United Nations Population Fund (UNFA) provide avenues for support and performance-based grants [12,13].



Energy & Carbon: Clean backup for rural clinics



In rural Cambodia, unreliable grid power often means clinics run **dirty diesel backup generators**. By using **solar-charged batteries** instead, we ensure reliable care with far lower carbon impact 🌍



What we **count** (GHG boundary)

SCOPE 1

Avoided Scope 1

Diesel combustion backup kWh that would otherwise come from a genset during outages (common clinic baseline).

SCOPE 2

Grid electricity

the small share of residual daytime kWh still drawn from the grid.

SCOPE 3

Embodied carbon

one-off footprint of PV panels, LiFePO₄ battery, inverter and balance-of-system components (capital goods).

Why it's **low-impact**



Energy minimisation first → pumps only dose on float calls in short bursts; daily load ~1.3 kWh (tiny compared to most onsite treatment systems).



Grid-first design → prioritises low-carbon grid electricity during the day; solar-charged battery just covers outages and night runs



Diesel displacement → avoids standby generator use, which is typically the dirtiest and most expensive kWh in clinics.

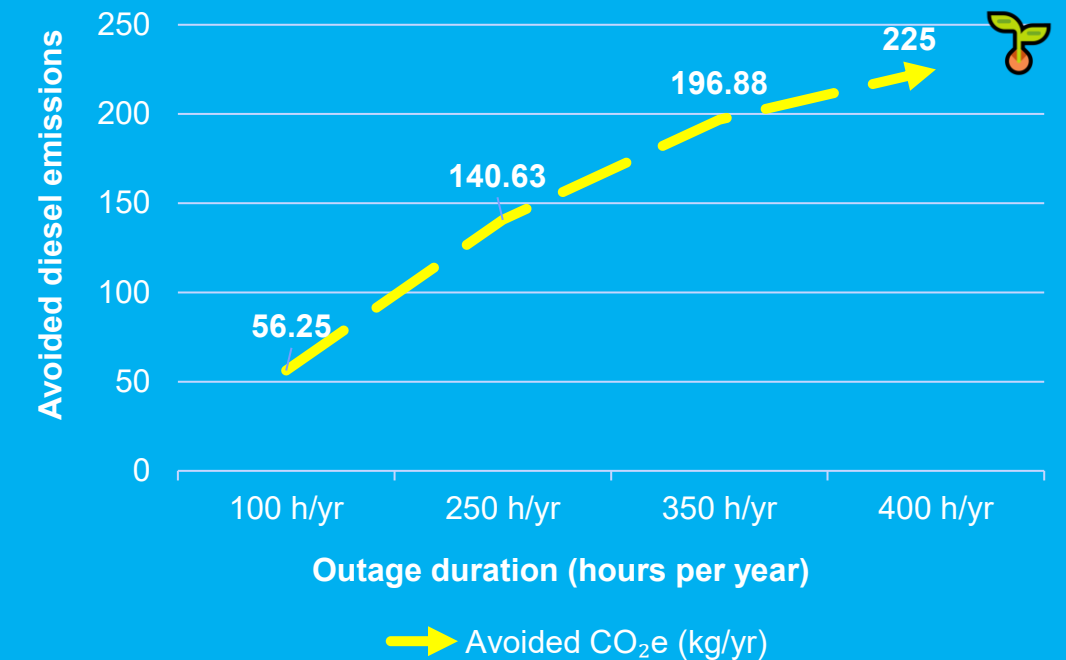


Material stewardship → long-life LiFePO₄ battery, modular pumps, and raised cabinet design (resilience = fewer replacements, lower embodied carbon).



Resilience as sustainability → service continuity during outages/storms means no environmental spills, no unsafe discharges, and no backup genset emissions.

Avoided diesel emissions vs outage hours (kg CO₂e/yr)



Carbon at a Glance

1.3 kWh/day
 290 kg CO₂e embodied
 120 kg CO₂e/yr (grid)
 200 kg CO₂e/yr avoided diesel
Net: -80kg CO₂e/yr

Payback Timeline

This means the system **pays back its carbon in ~3-4 years**. After that, it continues to deliver **net carbon savings every year**

Impact in Action

That's like planting **~15 trees** and letting them grow for 3-4 years! 🌱


Sustainability & Impact

In sustainability, we look beyond just emissions. True impact means balancing **the triple bottom line** – people, planet, and prosperity. For us, that also means embedding **WASH** outcomes at the center: ensuring clean water access, safe sanitation, and resilient services in vulnerable communities




What we count


People (Social)

 Health, safety, WASH access, and community equity.
(e.g. clinics stay open with reliable water supply during outages)

Planet (Environmental)

 Carbon reduction, resource efficiency, circular design. (e.g. clean backup avoids diesel emissions, protects water quality)

Prosperity (Economic)

 Affordability, cost savings, sustainable growth. (e.g. cost-effective WASH services vs. diesel reliance, fewer repairs)

Why it matters

Triple Bottom Line → sustainable projects must benefit people, planet, and prosperity.

WASH link → reliable clean water & sanitation services underpin health, gender equity, and resilience.

UN SDGs alignment → especially SDG 6 (Clean Water & Sanitation), alongside SDG 3, 7, and 13

Resilience as sustainability → systems that ensure care and water access continue, even under stress.

Our impact connects directly to the UN Sustainable Development Goals (SDGs), driving progress on clean water, health, energy, and climate action



Our sustainability impact compounds year on year - avoiding emissions, securing WASH services, and building resilience

Thank you!

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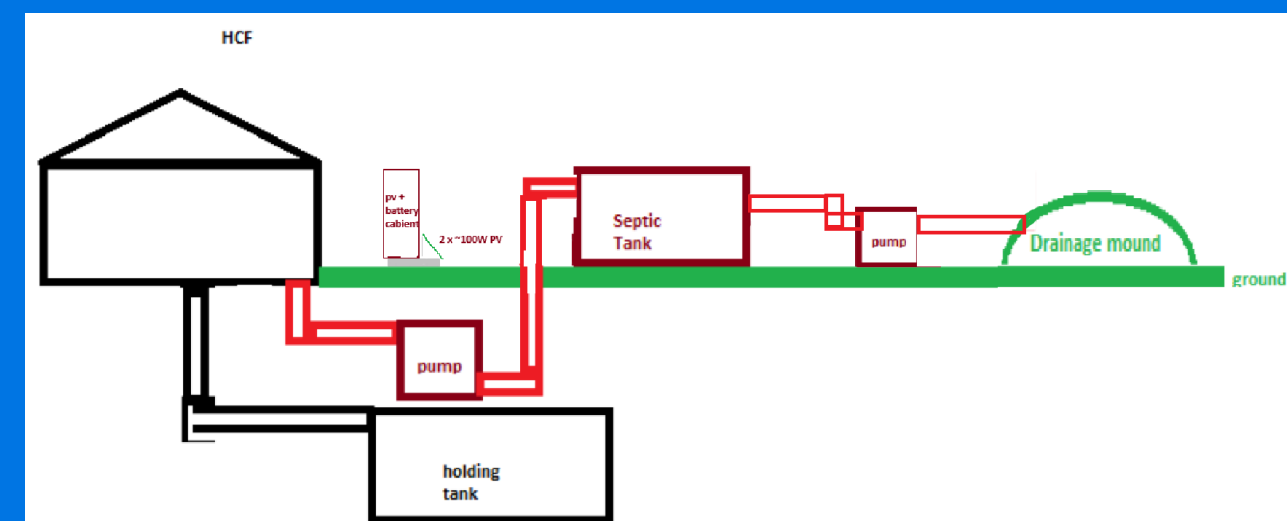


Image: Blooper! SEW Winnovators first draft of the solution.