

# On the science and legalities of the Safe Water Garden

*Paper production sponsored by Mr Tino Reppe/WIKA MENAT*

## 1. On the legalities of safe sanitation

### 1.1. On the Definition and legal aspects of safe sanitation

The United Nations working group on WASH, JMP, has established a [safety ladder for sanitation solutions](#), with “safe sanitation” (also known as “safely managed sanitation”) at the top, “basic sanitation” just below it, and “open Defecation” at the bottom. Whereas the definitions below “safe sanitation” leave some room for interpretation, the definition of safe (or safely managed) is universal, see also this [UNICEF paper](#). Since 2015, the UN recognizes “safe sanitation” as a human right. This ladder definition (especially the definition of “safe”) is adopted by every country in the world in their national standards: countries, as well as the world largest sanitation NGO –*Finish Mondial*– assess sanitation systems using the UN standards.

The Safe Water Garden (SWG) is recognised as a *safe sanitation system* from a definitional & legal point of view:

1. Finish Mondial is the world’s largest sanitation NGO and it only supports *safe* sanitation. It is also the only global organisation that makes assessments of stand-alone sanitation systems. Given the high stakes and the legal liabilities, their scientific board is made up of the world’s foremost sanitation experts. Thus, when they [assessed the SWG to be safe in 2025](#) after a 2-year long assessment process that included field visits, it signifies the consensus view of the global scientific community.
2. It is up to each individual country to assess sanitation systems deployed within their borders. The Indonesian standards board [officially assessed](#) the SWG as a safe wastewater treatment plant in Dec 2019. The chief author of the report, Dr. Elis Hastuti, is one of the co-authors of this report
3. Temasek Trust (Singapore) lauded SWG as one of its [2023 SL25 winners](#) (specifically listing the SWG as safe sanitation) and subsequently listed SWG on its prestigious [Co-Axis platform](#), again as a safe sanitation system, thus reaffirming the SWG is recognised as safe (these bodies are very careful before stating claims that have legal meaning). Recent tests conducted in collaboration with the National University of Singapore (NUS) and Outward Bound Singapore (OBS) on two research SWGs on Pulau Ubin reaffirmed once again that the SWG is safe.
4. The United Nations invited SWG in 2023 to exhibit as one of only 6 examples of a scalable nature-based WASH innovation at the New York UNWC, [once again implying that the SWG is safe](#).

Thus, the safety of the SWG is firmly established from the legal and scientific point of view. In this document, we share some more background details for those interested in the science and politics of safe sanitation.

Fortunately, the standards for safe sanitation are quite easy to understand (as they should be): a sanitation system is considered *safe* when it is safe for the users, meaning it must eliminate *direct* safety risks associated with wastewater, but it also must eliminate *indirect* safety risks stemming from pollution of drink water sources. Finally, UN SGD 6.2 reminds us that for virtually every stand-alone sanitation system, part of the safe water treatment management is also the safe and responsible *disposal of sludge* that accumulates over time in the system. But in the SWG, as explained below, the sludge is deposited safely underground and hence not a point of separate concern.

### 1.2. Sanitation safety as it affects the environment

Since human wastewater is organic in nature, the waste barely pollutes (threatens) the environment at large.

Unprocessed wastewater is bad for people, not so much for nature. To explain this, let’s consider the key harmful components of wastewater:

1. Bacteria, parasites, viruses
2. Organic molecules
3. Nutrients like Nitrogen and Phosphorus

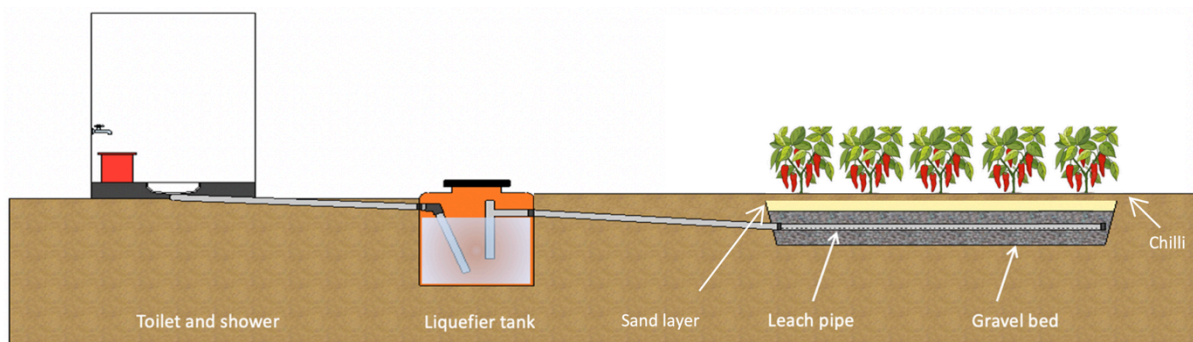
The first component poses no environmental risk; it is only a risk for people.

The second and third components are only harmful for the environment if they would make their way into the open waters, where their release would lead to oxygen deprivation in the water, threatening its resident marine life. Organic molecules, when released into the tropical soil (via soak pits or basic or safe sanitation systems) will be consumed and neutralized in the soil by bacteria (which thrive in tropical environments), removing this risk for the environment. Nutrients can only be intercepted by trees or plants whose roots absorb the nutrients. But trees are not suitable since tree roots tend to invade and clog the sanitation system, while plants absorbing the nutrients will release the same nutrients when they die (and hence not solve the problem). There are ways to remove (most of) the nutrients, but they are expensive and CO<sub>2</sub>-intensive, and hence not economically realistic, more so since the vast problem with rural nutrient pollution of open waters is not from people but from agriculture (agricultural nutrient release is around 3 times that of human release and hence probably around 10 times rural human release). Finally, some countries (like Indonesia) have laws on the books that prevent the use of human waste directly or without treatment as fertilizer, which could challenge the use of sanitation leach fields (see below) to grow plants. The Indonesian standards board managed to overcome these legal objections to using the Safe Water Garden as a low-cost technology option for growing small-rooted plants by leveraging the professional input from the agriculture department of Indonesia's oldest and most respected university, *Universitas Gajah Mada*. But in general, human waste nutrient removal at the village level remains politically tricky, costly, and rather insignificant compared to the nutrient pollution caused by agriculture. Therefore, the international focus of rural safe sanitation is squarely on how it affects *people*, the topic of our next section.

### 1.3. Sanitation Safety as it affects people

Every type of sanitation that is considered less than safe (pit latrines, soak pits, open defecation, low-quality septic tanks etc) is so qualified because it allows for *open-air contact* between wastewater and people, so that flies can carry diseases into people's homes. Therefore, the key target for a safe sanitation system is to eliminate such open-air contact.

A good septic tank system does this, and so does the Safe Water Garden, as is obvious from its design (see diagram below): ultimately, the wastewater is safely released into the soil under the garden. Since none of the "pollutants" listed in section 1.2 can travel upward, open air contact is eliminated. Aside from the critically important health aspect, the "no open-air contact" also vastly improves people's sense of dignity since their houses no longer smell.



After a system passes the obvious direct "no-open-air-contact" test of safety, it also needs to pass the *indirect* test of safety: Does the system pollute nearby water sources that people use for bathing or drinking?

International consensus holds that a water source (for example, a shallow well) must be positioned at least 10 meters away from a sanitation system. As a result, (inter)national assessors verify the pollution levels of wells 10 meters away from the sanitation system, checking the water source for the 3 types of pollutants listed in section 1.2 and checking that these values remain within (inter)nationally accepted boundaries.

The Indonesian government ran such tests and published them in their 2019 report. *Finish Mondial* based its assessment in 2025 on the above considerations and the fully recognized tests by the Indonesian government.

Safe Water Gardens ran independent –much more challenging– tests together with the *National University of Singapore* in 2017, testing the water quality in high groundwater conditions much less than 10 meters away. We found –as expected by our lead scientists– that the pollutant levels were at acceptable values on as little as 1 meter distance from the Safe Water Gardens. To overturn the international –but impractical and widely ignored– guideline of 10 meters distance between sanitation system and water source, we would need to run 50 of such tests and invite a team of top professors to sign off on the result. We will gladly run these tests to obtain this globally significant result if we could find a sponsor ready to pay us the approximate US\$200,000 needed to fund such official research.

This concludes the chapter on the safety aspects of the Safe Water Garden.

## 2. On the science behind the Safe Water Garden

### 2.1. The scientific reason for success is simple physics and biology

The Safe Water Garden resembles, at first glance, a septic tank system as it follows the same principle: a collection unit (tank) and a secondary treatment component (a garden, known in sanitation science as a leach field). The important difference is that a septic tank accumulates *sludge* (which must be cleaned regularly, posing one of the greatest problems for developing world sanitation), whereas the SWG tank is a *liquefier* that accumulates no sludge and needs no regular cleaning. Close to 1,500 systems, the oldest of which stem from 2015, attest to this.

The scientific secret behind the liquefier process is simple physics: faeces floats and hence stays in the elbow of the incoming pipe, while subsequent users dissolve the faeces by repeatedly flushing the toilet. We have [tested this explicitly and scientifically](#) in Nagrak village, close to the Indonesian Standards Office in Bandung, where 30 SWGs have served 92 families since 2021. It turned out that, even under heavy use (7 families for 1 SWG), there is no sludge at the bottom (just a bit of mud on account of people enter the washroom with dirty feet), and that there is only occasionally a layer of scum that maxes out at 15 – 25 cm thickness (this happens for biological reasons we do not fully understand, although we knew, of course, that every natural process ends up at an equilibrium, so we were expecting some upper bound). The users could simply leave the tank alone and leave the small layer of scum in the tank, or they could regularly dispose of it by burying it safely underground (as the scum is only a few buckets-full)

As with many other existing sanitation systems (such as pit latrines), the soil acts as a filter for the first 2 of the 3 pollutants listed in section 1.2: bacteria, parasites and viruses from wastewater (already reduced by anaerobic processes in the tank) get stuck in the soil, while organics and some nutrient compounds are consumed by anaerobic and facultative bacteria present in the SWG tank as well as in the soil underneath the SWG garden. As a well-established sanitation fact in tropical environments (see for example page 8 of a [UNICEF report](#) on sanitation after the Aceh Tsunami), there is no risk of accumulation of pollutants under the SWG; again, a natural equilibrium will form.

### 2.2 Grey water processing and the SWG

Grey water (non-toilet wastewater such as shower water, kitchen wastewater and laundry water) is generally considered to be OK for release into sanitation systems despite the presence of soap (refer to the UNICEF and USAID papers mentioned above). Briefly, this is because, these days, most detergents are bio-degradable and because the prevention of stagnant wastewater puddles is so important for safety. The UNICEF and USAID papers also encourage the release of kitchen wastewater into the sanitation system, but here is where the SWG deviates.

We discovered early on that kitchen wastewater can lead to maggots and worms in the tank, rendering the tank inoperable after a while. This is why we had to separate the kitchen sink (with its own small mini leach field) from the SWG system. Once we started constructing kitchen sinks for the many families who did not have one, we discovered that on a national scale, more than 75% of village families do not have a kitchen sink. Next, we then also discovered from personal encounters (and our own surveys) that a kitchen sink is a valuable addition in its own right. A simple kitchen sink costs as little as € 40 but it immediately promotes people's pride of their home. In themselves, just like all other WASH assets, kitchen sinks immediately deliver human dignity. We therefore believe kitchen sinks should be viewed as essential, not just to ensure that the SWG works properly, but to confer dignity.

## 3. Why the Safe Water Garden is the world's cheapest safe sanitation system

In the science and international rules of tropical sanitation, the minimum requirement for an *adequate* (also known as *basic*) sanitation system is that it be a 2-stage system: (1) some sort of wastewater collection facility (typically a tank), followed by (2) some sort of leach facility, as in the diagram above. The reader is referred to the extensive post-Aceh tsunami reports from [UNICEF](#) and [USAID](#) to read about these minimum requirements.

Since a 2-component sanitation system is regarded as the minimum standard for a *basic* system (one step below *safe* sanitation in the UN definition), it is therefore also the minimum standard for a *safe* sanitation system.

The Safe Water Garden (SWG) was the end-result of a 2-year research collaboration with the *National University of Singapore (NUS)*, *Universitas Gadjah Mada (UGM)*, and the *Technical University of Eindhoven (TU/e)*, precisely to (cost)optimize such a 2-component solution while ensuring it is safe.

In the SWG setup (refer to the diagram above), for component (1), the collection tank, we simply took the smallest widely available tank, a 500 liter plastic (PE) tank, while for component (2), the leach field, we simply followed the usual international recommendations to make the leach field functional even in conditions where the soil does not easily absorb water. Because a tank smaller than 500 liter is not possible (we tried), and the leach field follows the

usual requirements, the SWG is the cheapest 2-component system. Our research showed the system is safe, which was subsequently legally and scientifically affirmed by Indonesia's Human Settlement Research Institute and Finish Mondial (see section 1). Therefore, the claim in the section title is no idle boast or marketing gimmick, but a simple scientific fact.

It is a very important fact too, since –as highlighted in the UNICEF and USAID reports– one of the biggest obstacles to providing tropical village families with safe sanitation is *cost* and *maintenance ability*. Indonesian village families live on average on well under US\$ 200 per month, so a sanitation system costing thousands of dollars is just not feasible. For a solution to be realistic, it must be affordable. At an average cost of US\$ 200 per family (provided the community has learned how to install the SWG themselves), the SWG meets this very important financial criterion.

Not only is the SWG the world's most cost-efficient system to build, but it is also (by far) the most cost-efficient system in the long-term; first, because it does not require costly desludging or other maintenance and second, because its lifetime is estimated to be many generations (PE and PVC pipes are expected to last at least a century when buried underground such as with the SWG tank, and gravel and sand last forever).

## 4. Why the Safe Water Garden is recognised as a scalable solution

The UN invited Safe Water Gardens to exhibit at the New York UN Water Conference in 2023 as one of only 6 examples of a scalable WASH solution ([see poster overleaf](#)). [Co-Axis](#) decided to list us in 2024. Finish Mondial [listed the SWG](#) in 2025 as one of only 9 global stand-alone safe sanitation solutions.

These organisations did so because of the following features of the Safe Water Garden (the SWG), some of which are unique to the SWG.

The SWG ...

- **is safe.** *The SWG is legally assessed to be safe, giving peace of mind to governments, sponsors and users*
- **is maintenance-free.** *In particular, the SWG requires no desludging. This very important feature is unique amongst safe sanitation systems.*
- **is affordable.** *3–6 times cheaper than alternatives, the SWG brings rural safe sanitation within national budgets*
- **builds local capacity** since the SWG ...
  - **is built and owned by the user.** *The SWG can be installed in 1 day by the user (unlike other safe sanitation systems that require professional installation) and it transfers full ownership to the end-user*
  - **catalyzes complete WASH.** *The SWG acts as engine for a full WASH solution incl. running & drinking water*
  - **catalyzes micro-farming.** *Since SWG garden can support chili, families are reminded they can micro-farm.*
  - **restores dignity and livelihoods & hence arrests rural exodus.** *A house with a beautiful washroom and a house that does not smell bad anymore is a house that is open to visitors and open for business. More than 90% of SWG users surveyed announce that they are keen to start a micro-business, and in Indonesia, families can start a micro-business free of charge, within 30 minutes, online.*



Safe Water Gardens (SWG) Pte Ltd was invited to exhibit the poster below at the **UN HQ, New York in 2023** as one of (only!) 6 examples of a scalable WASH innovation.



—UN—  
2023 WATER  
CONFERENCE

NEW YORK  
23-24  
MARCH  
2023

## SAFE SANITATION for < \$ 250 per FAMILY for all village families in (sub)tropical countries by 2030

### THE PROBLEM for (sub)tropical village communities :

While there is typically enough water, sanitation is sub-standard, and is the key driver behind an unsustainable exodus to the cities.

### THE SOLUTION :

Developed in an ongoing broad public-private partnership, the **Safe Water Garden** is a single-sized sanitation system suitable for small schools & groups of families.

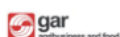


### THE SAFE WATER GARDEN ...

- can be installed in 1 day
- transfers full ownership to end-user
- is maintenance-free
- is 3-6 times cheaper than alternatives
- acts as engine for a full micro-WASH solution incl. running & drinking water
- catalyzes micro-farming, healthy food habits & micro-businesses
- recycles pre-existing village waste
- can be produced from recycled plastic
- restores dignity & arrests rural exodus

### DISTRIBUTION MODEL

- In each district, we turn one village into a *Model Village Program (MVP)* by "teaching the teachers". Each such MVP then powers a regional rollout.
- Companies pay MVP training, village funds pay for materials, end-users can access micro-loans for WASH add-ons
- Community-driven (census) data provide project transparency and QC
- **We can rapidly scale .... because all stakeholders manifestly benefit**



Watch  
2-min  
movie



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Above: a sample of our ever-growing partnerships with government, industry, academia, and NGOs.

JOIN US!