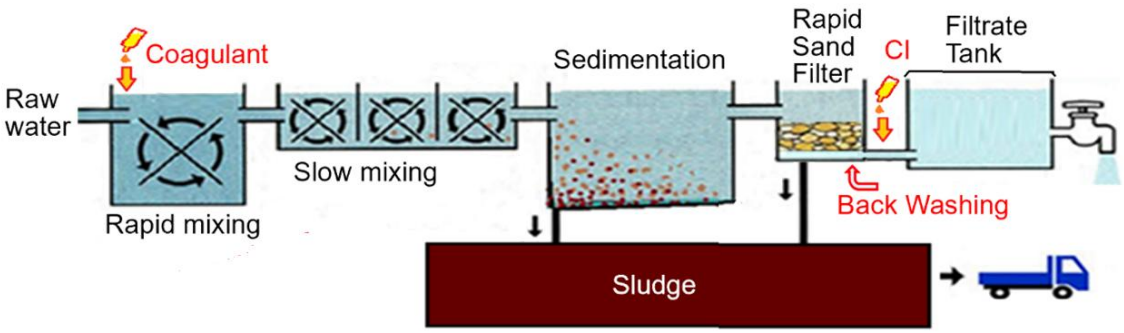
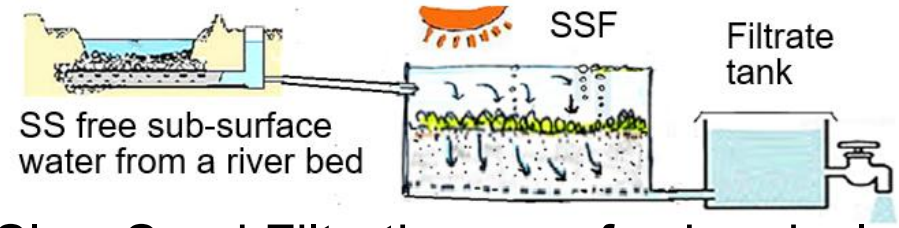
⑤ URF and EPS Model.

Rediscovery of Slow Sand Filter of chemical free treatment from Chemical treatment of Rapid Sand Filter.

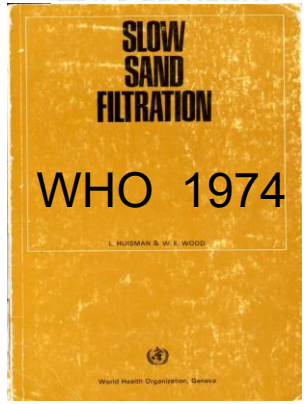
⑤28 slides

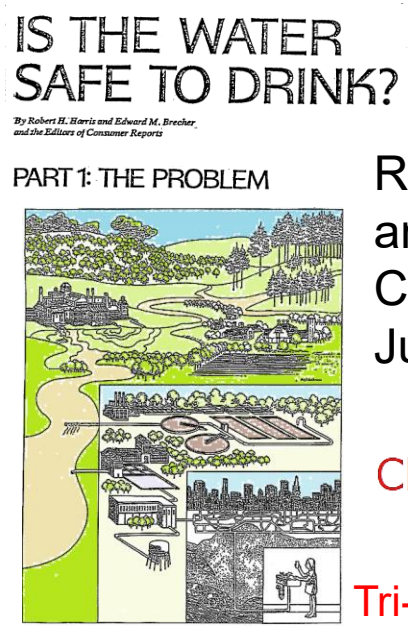


Filter clog　　Tast, Odor algae

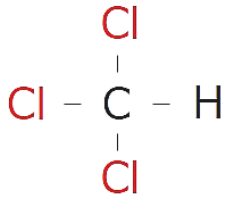


Slow Sand Filtration: a safe chemical-free purification method, by Huisman and Wood, 1974

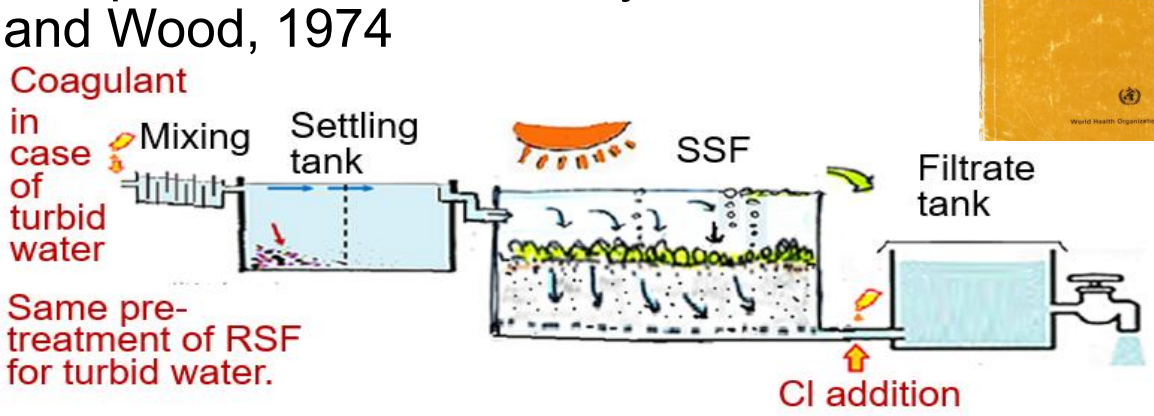




Robert H. Harris and others Consumer Report, June, 1974.

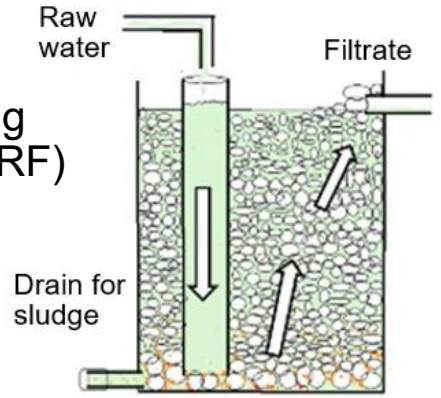


Tri-halo methane



Clear seepage water in the flood plain

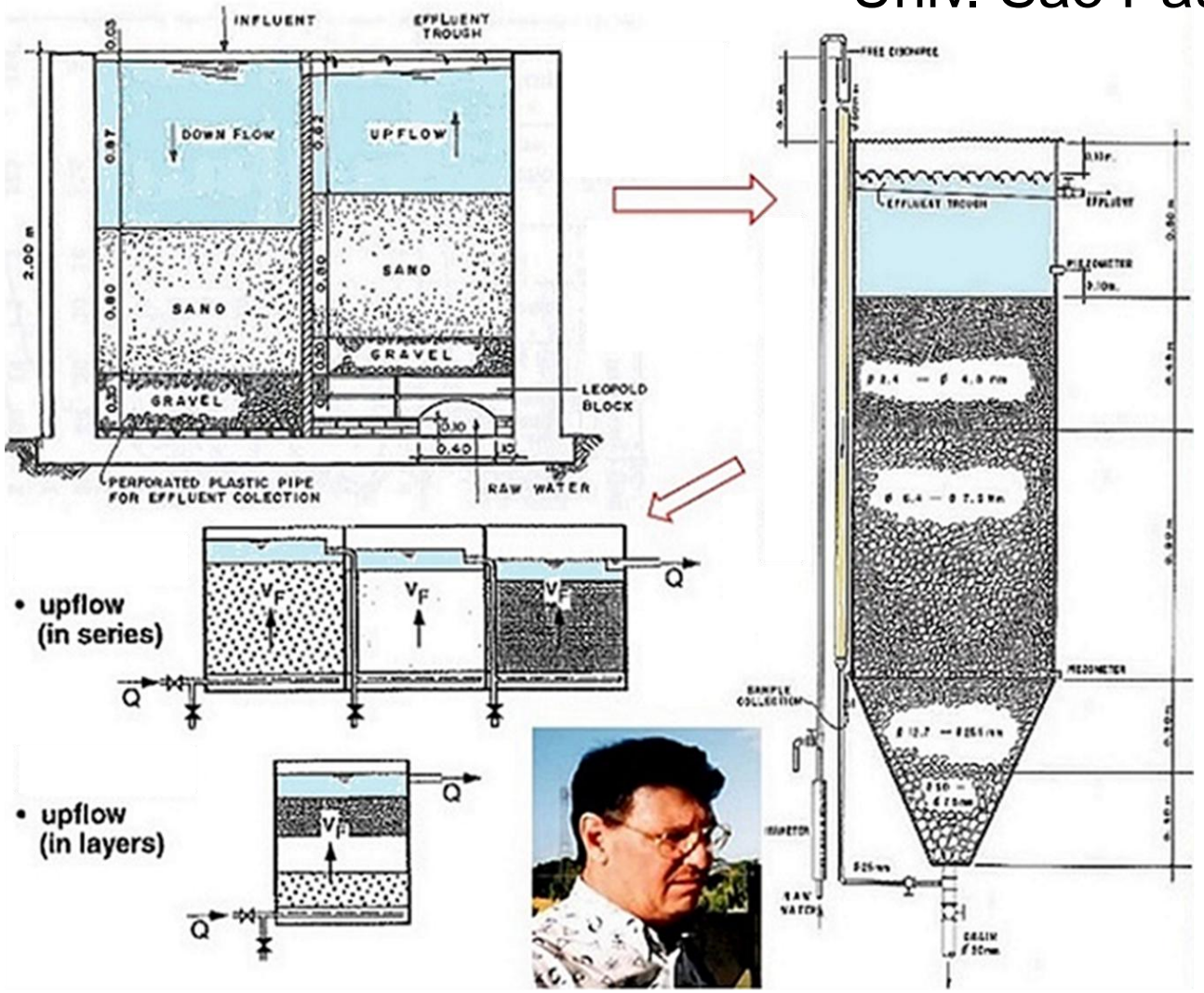
Up-flow Roughing Filter (URF)



Clear filtrate without chemicals

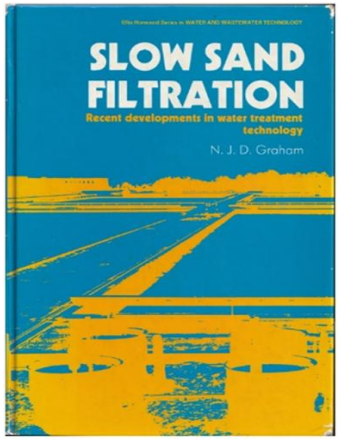
Development of Eco-friendly and Chemical-free turbidity countermeasures: **Up-flow Roughing Filter.**

Down Flow and Up-Flow

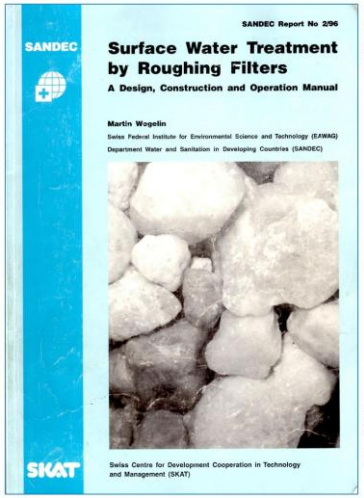


Luiz Di Bernardo 1980
Univ. São Paulo, Brazil

Up-flow Roughing Filter: presented at the International Conference on Slow Sand Filtration, London, 1988



At the international conference in 1988, Martin Wegelin from Switzerland reviewed past roughing filters
⇒International joint experiment
⇒In 1996, a roughing filter manual was published in Switzerland.

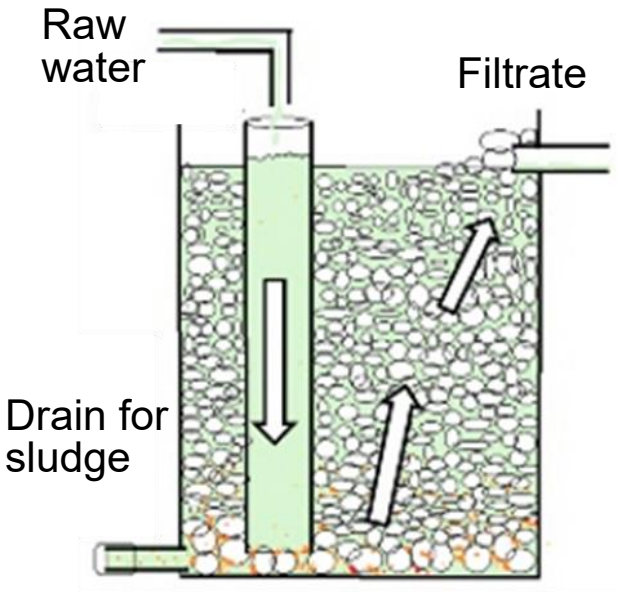


https://www.ircwash.org/sites/default/files/Wegelin-1996-Surface.pdf

Martin Wegelin
Swiss Federal Institute of Aquatic Science and Technology

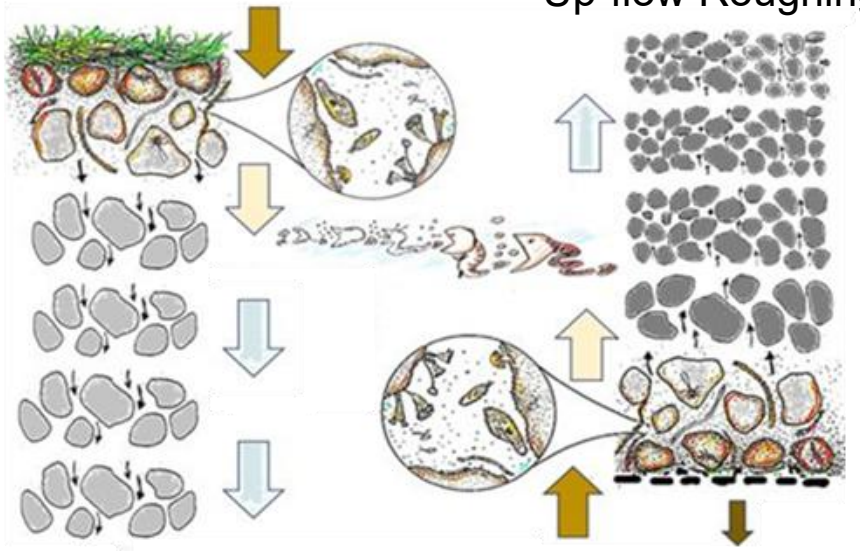
The role of the biological community was also key in Up-flow Roughing Filter.

Up-flow Roughing Filter

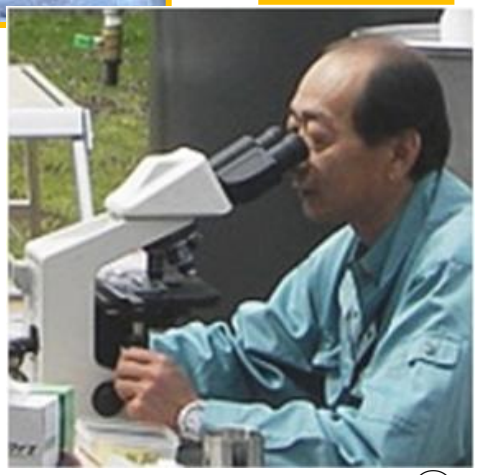


Slow Sand Filter

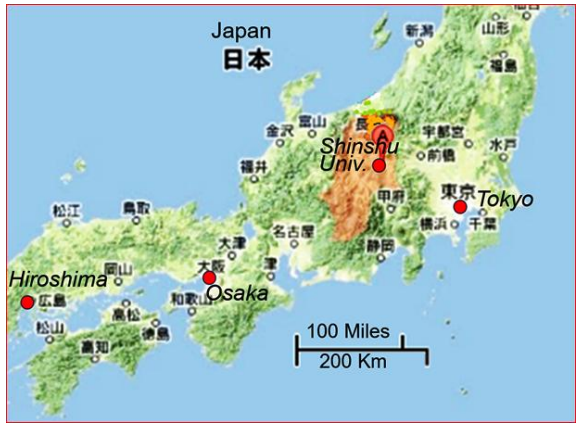
Up-flow Roughing Filter



It has good settling properties and is similar to activated sludge in sewage treatment, where the biological community is active.



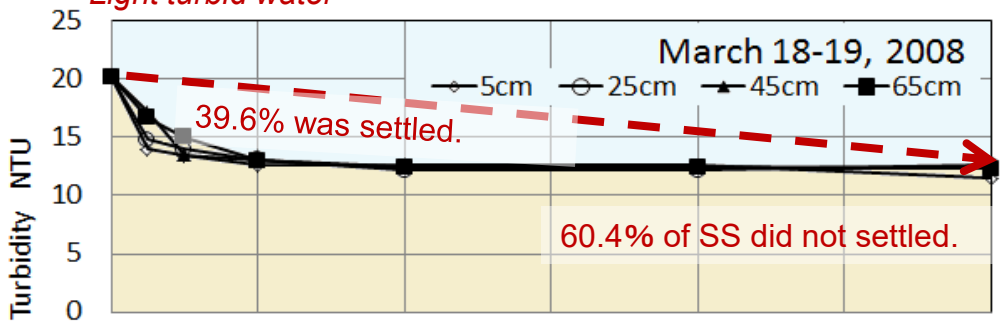
The activity of biological communities is key.

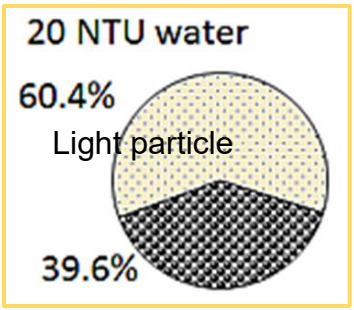


This result is for mountainous country.

*There were extremely small particles like as colloidal particles in case of small turbidity, like as less than 20 NTU. The rapid settling of turbid matters was observed **within 4 hrs**. However, a large portion of turbidity did not decrease.*

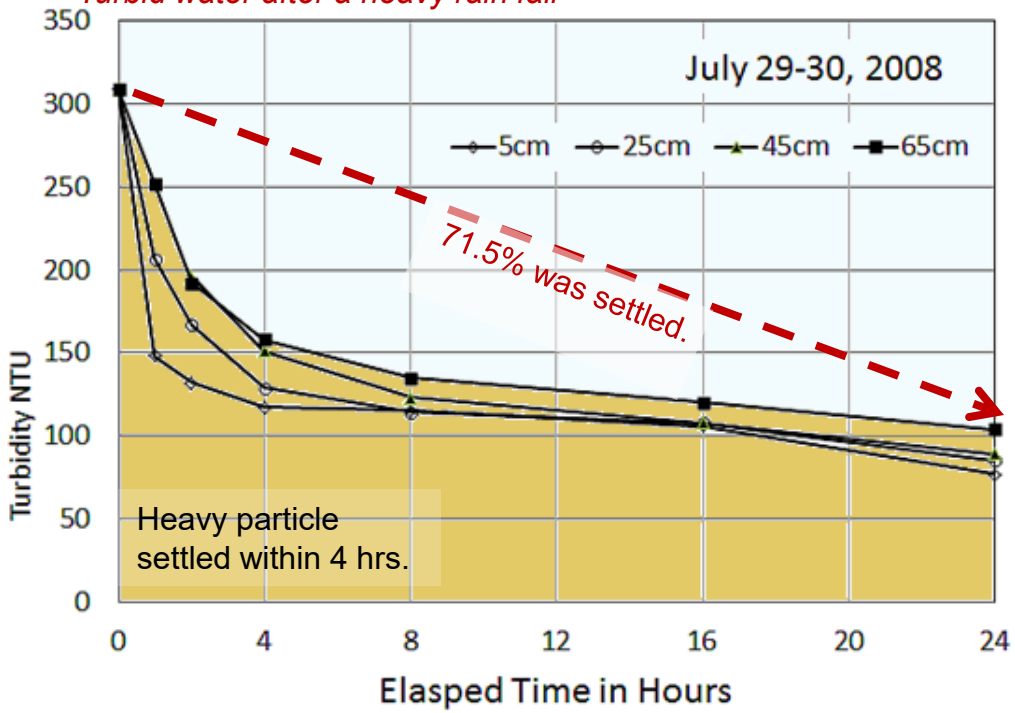
Light turbid water



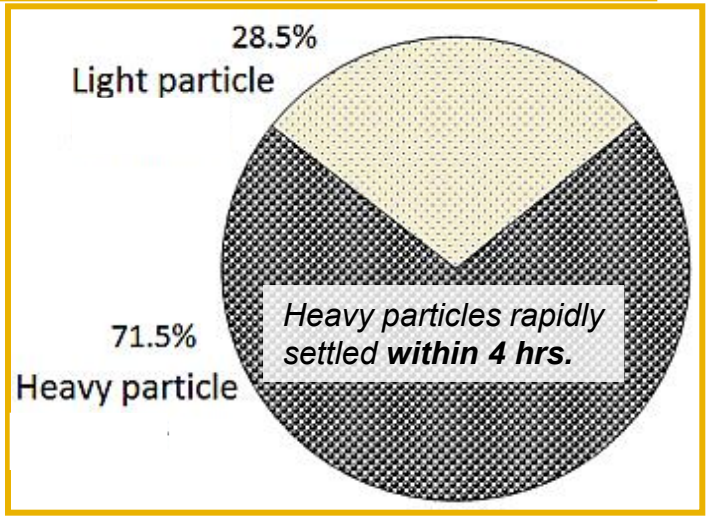


Light turbid water: small turbidity, a large portion of light particle.

Turbid water after a heavy rain fall



In case of turbid water, a large portion was heavy particles.



4 hrs. settling is enough.

After heavy storm event, river water becomes dirty and rapidly increases.

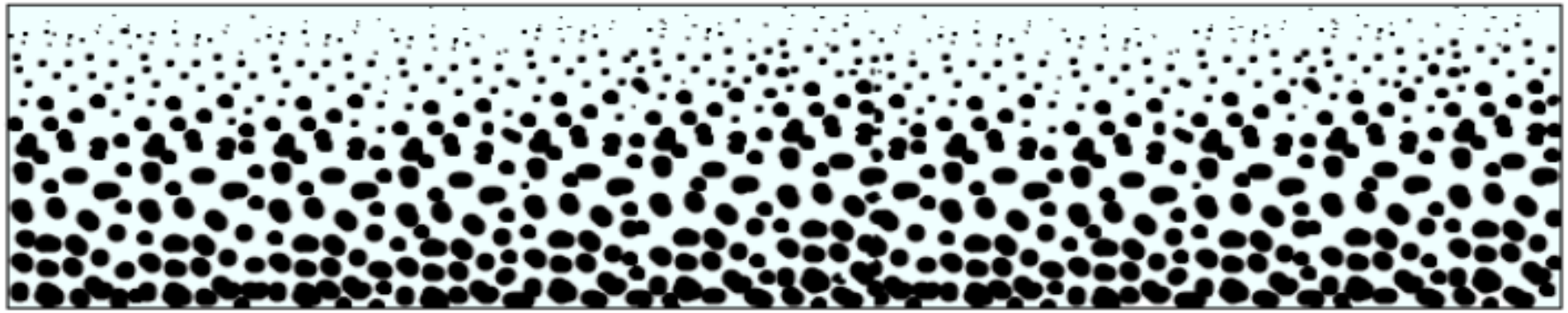
In Japan, river water is usually clear and small amount of water.

Clear and suspended free water from spring is found in a flood plain.

Light and small particle which is not easily settled.

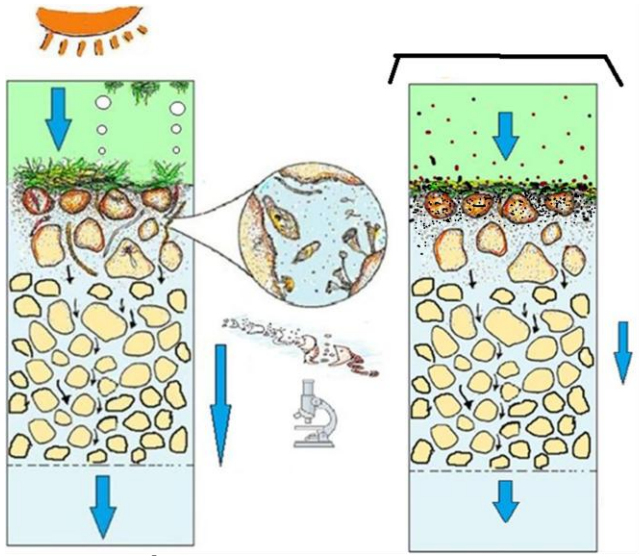
A large amount of heavy and large particles in a storm water.

Flood water is dirty. There is huge amount of soil matter from land surface.

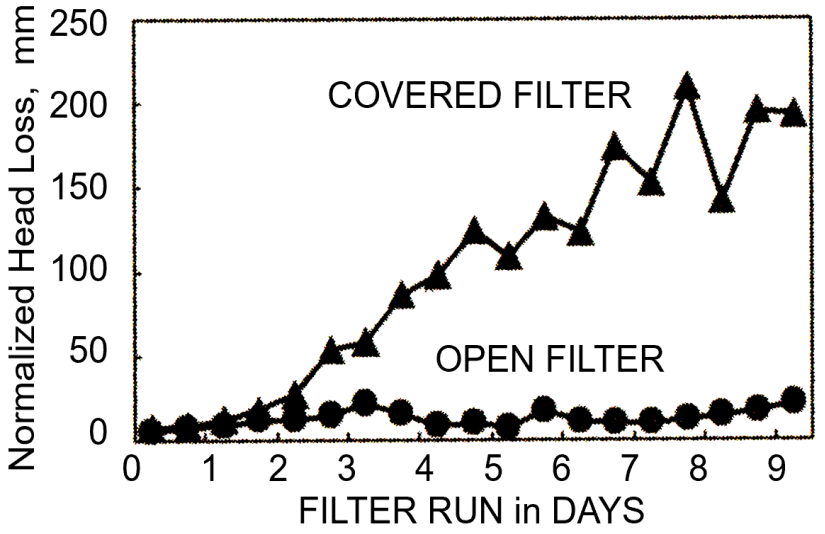


Multiple Roughing Filters to eliminate SS from an irrigation canal water.

Effect of open filter and covered filter.



Filter resistance (NHL) of Open filter was almost constant.
But the resistance of Covered filter increased almost every day.



Algal growth under sunshine.

⇩

Increase grazing activity by animal.

⇩

These animals search for food, make holes, and do not increase the resistance of the water.

W. K. Burton **1894** "**The Water Supply of Towns and the Construction of Waterworks**"

Berlin wks discovered that covered filters are much less efficient than open.
➪**Open is better.**

We confirmed the role of algae in EPS.

OISCA (The Organization for Industrial, Spiritual and Cultural Advancement-International)

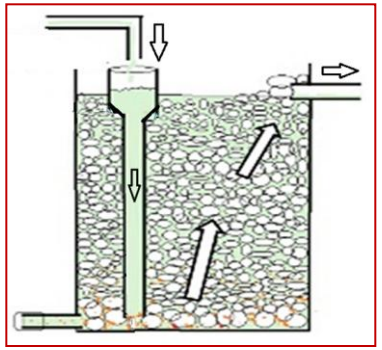
OISCA has started working on the idea that EPS, which applies natural mechanisms, can produce safe drinking water without relying on others.

There are sedimentation tank, 4 gravel filters, and slow sand filter. Polluted water turns to safe and reliable water quality.

Polluted water from River Kanda, Tokyo is pumped up in 2005.

No detection of coli-form bacteria, lead, herbicides of Atrazine and Simazine. Nitrate N concentration : 2.0 mg/L, Nitrite N: 0 mg/L, pH8.5, total hardness: 250 mg/L and residual chlorine 0 mg/L.

OISCA Tokyo:
polluted water
→EPS
→ safe water



I advised URF to him.

Mandalay, Myanmar: Pond → settling tank → 3 Up-flow Roughing Filters → Sand Filter → safe drinking water.

Try it ! **First, check it by yourself without any grant money.**

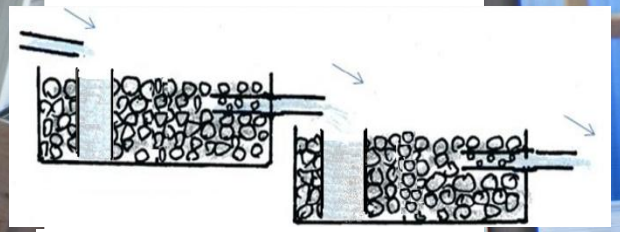
When you receive money, you start to consider the intentions of the person who gave it to you.

Three points worth to remember

1. Knowing is NOT enough, we must APPLY it to something useful.
2. Willingness is NOT enough, we must PUT it into the PLAN and ACTION.
3. Putting the PLAN into action is NOT enough, we must ACCOMPLISH the goals.

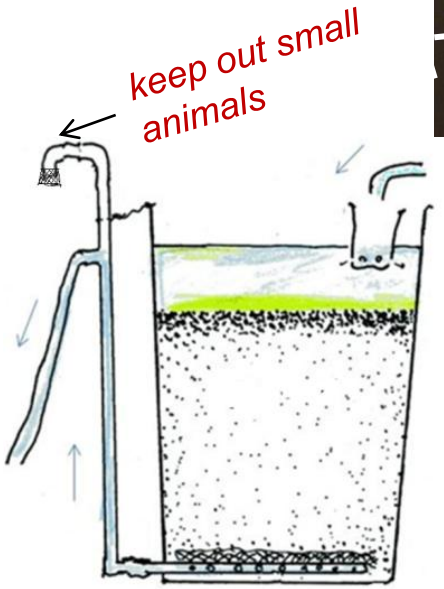
To make subsurface suspension free clean water in the flood plain.

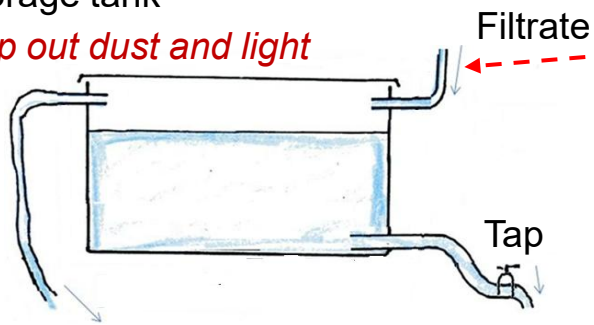
Filtrate storage tank



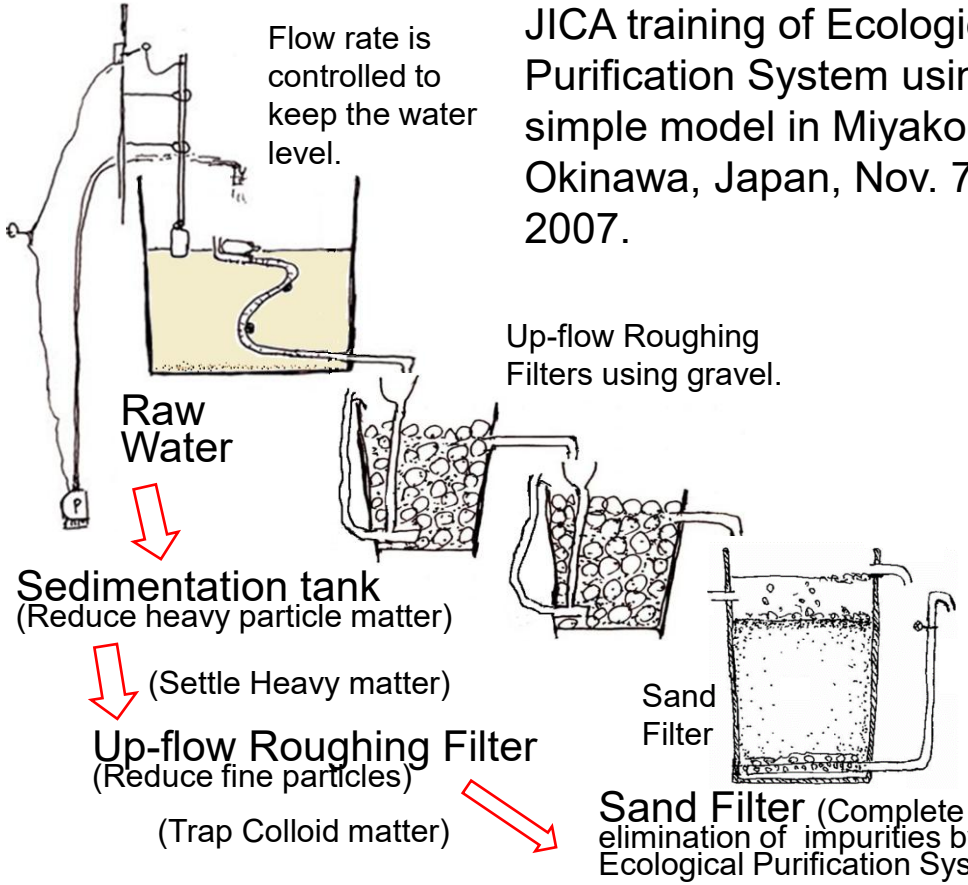
Up-flow roughing filter

To keep continuous flow by a small pump



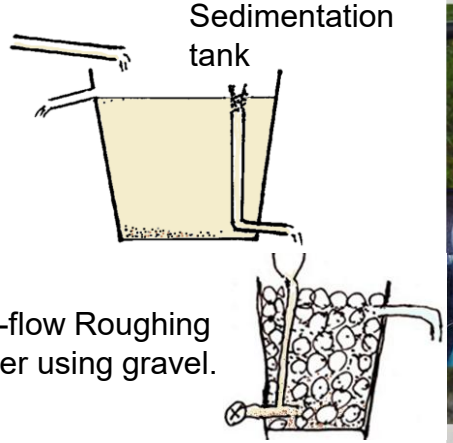


Under drainage porous pipe covered with mesh cloth.



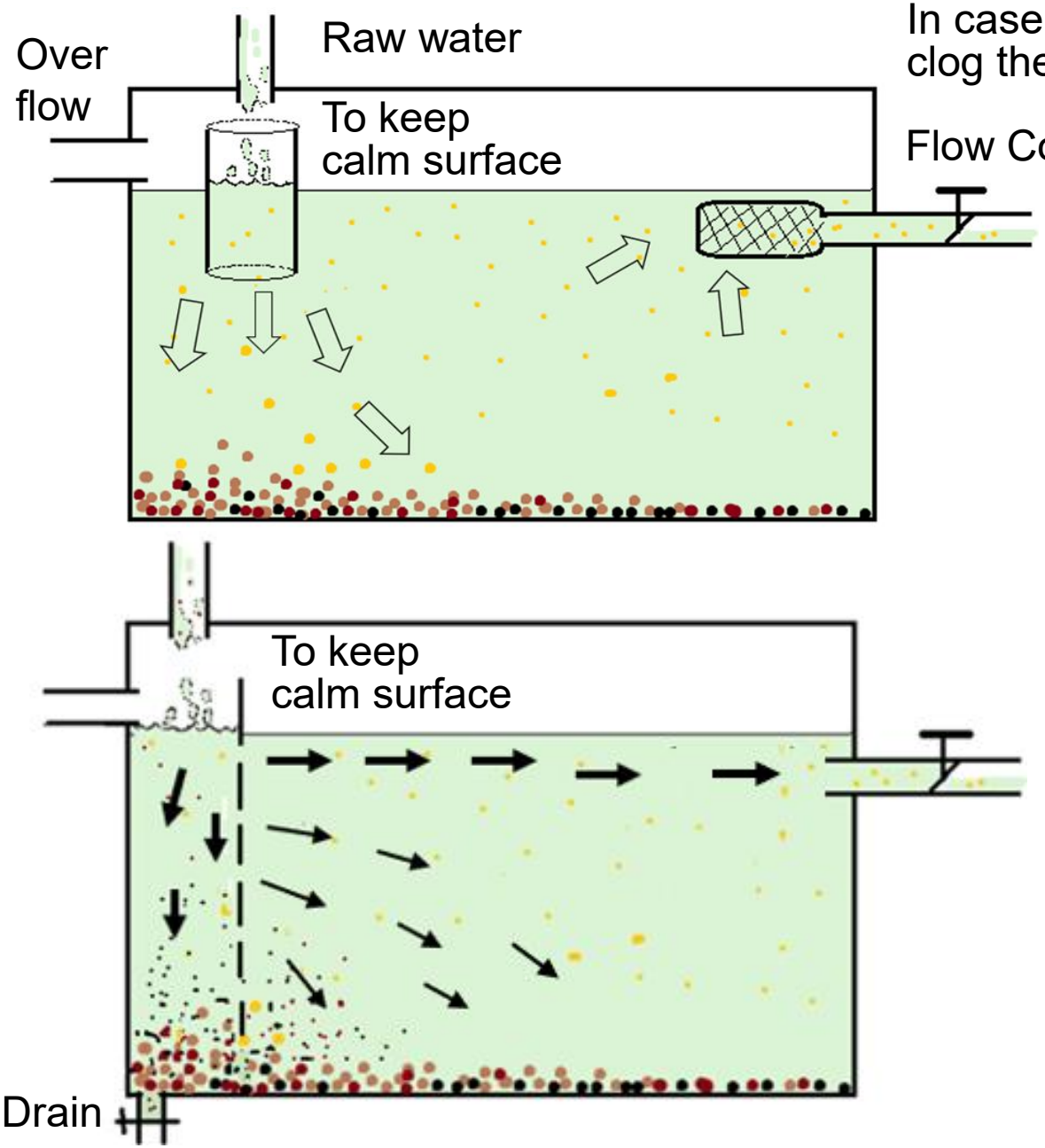
JICA training of Ecological Purification System using a simple model in Miyako-jima, Okinawa, Japan, Nov. 7th. 2007.

JICA training in Miyako-jima, Okinawa started from 2006.



JICA training in Okinawa,
in Feb. 2025.

Receiving Tank (Settling Tank)



In case of open tank, filamentous algae clog the outlet.

The Water Supply of Towns
by W. K. Burton **1894**.

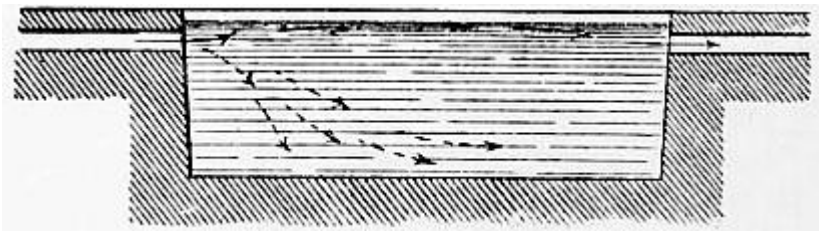


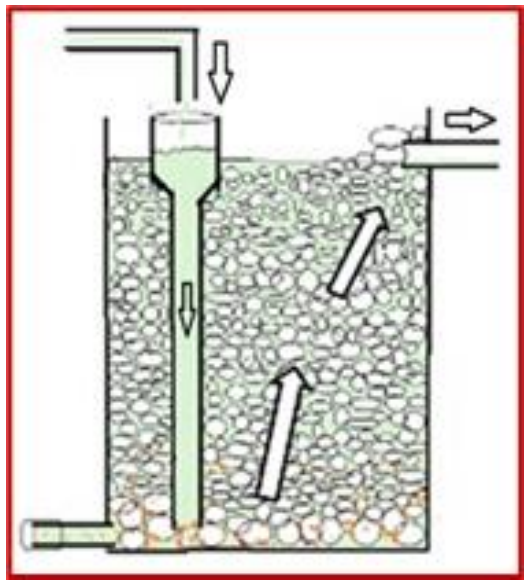
Fig.65. Settling reservoir: Inlet and outlet at surface level.

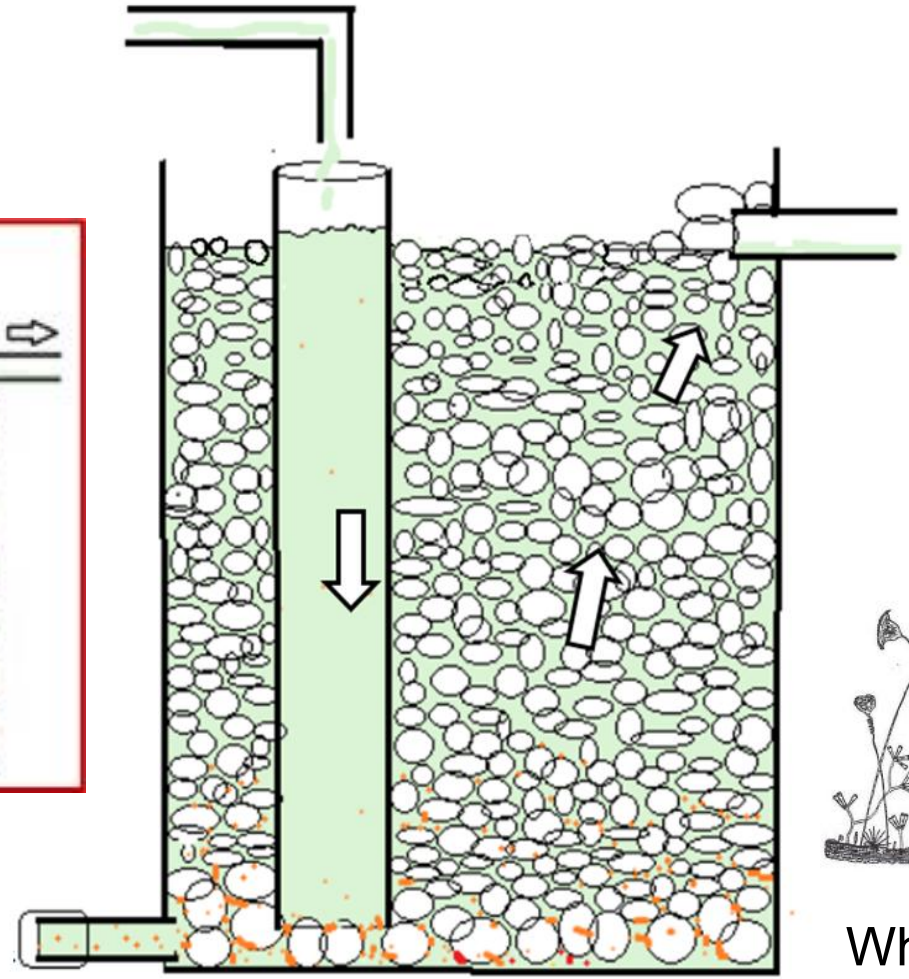
Heavy particulate matters are easily settled.

However, colloidal light particles like silt material are not settled in this settling tank.

Up-Flow Roughing Filter (URF): Gravel Filter

Additional URF if necessary.





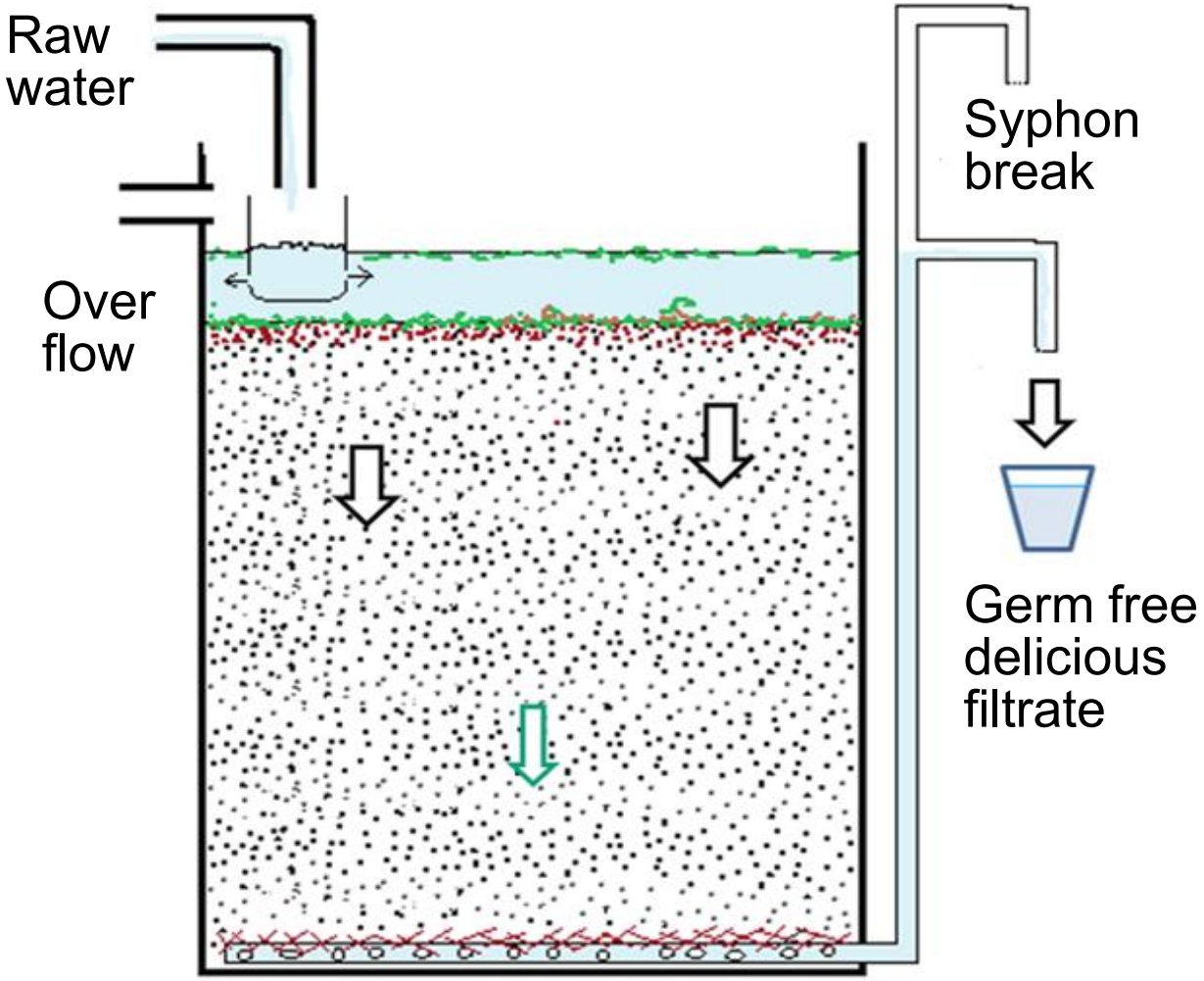
Drain cock for accumulated mud.

Colloidal fine particles adhesive to the surface of gravels. Small animals scrape them and produces fecal pellets. Fecal pellets accumulated to the bottom.

When the filter resistance increase, the drain cock is opened in short time to drain the mud (accumulated fecal pellets.)

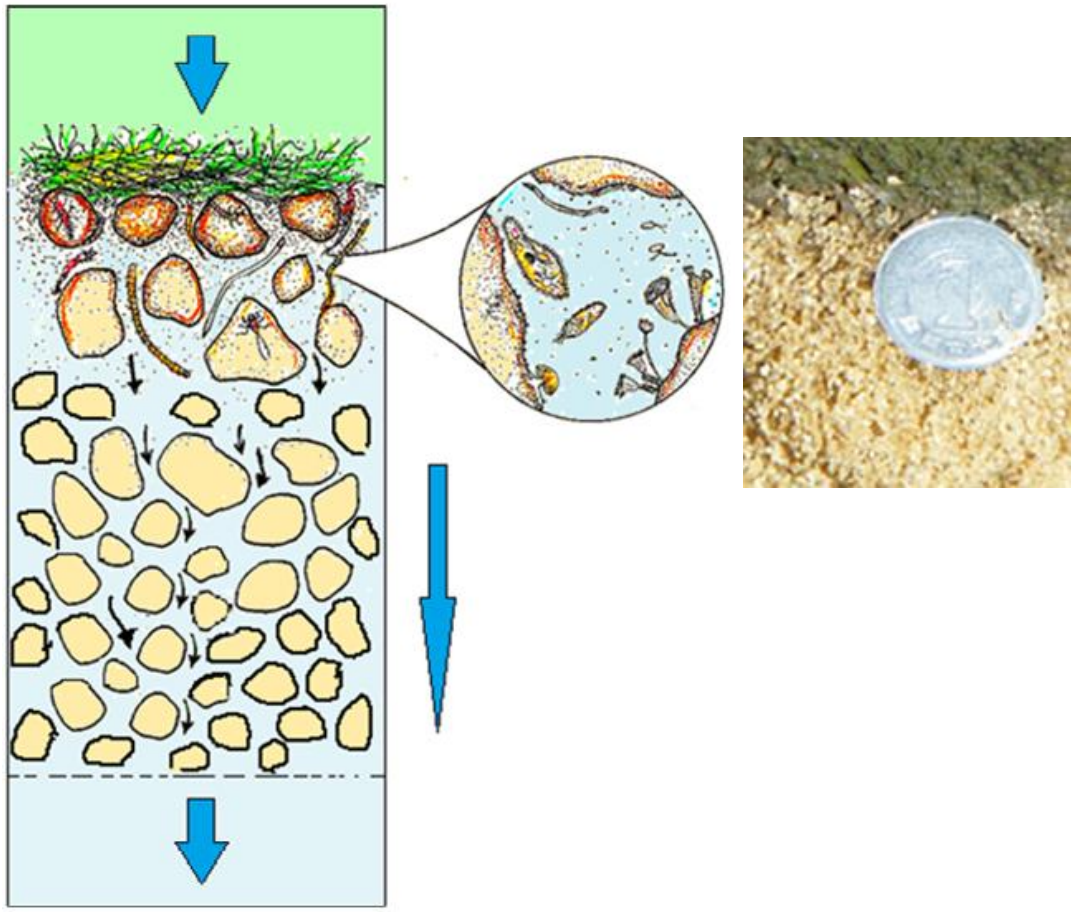
EPS (Sand) Filter (Natural Down Flow)

Ecological Purification System



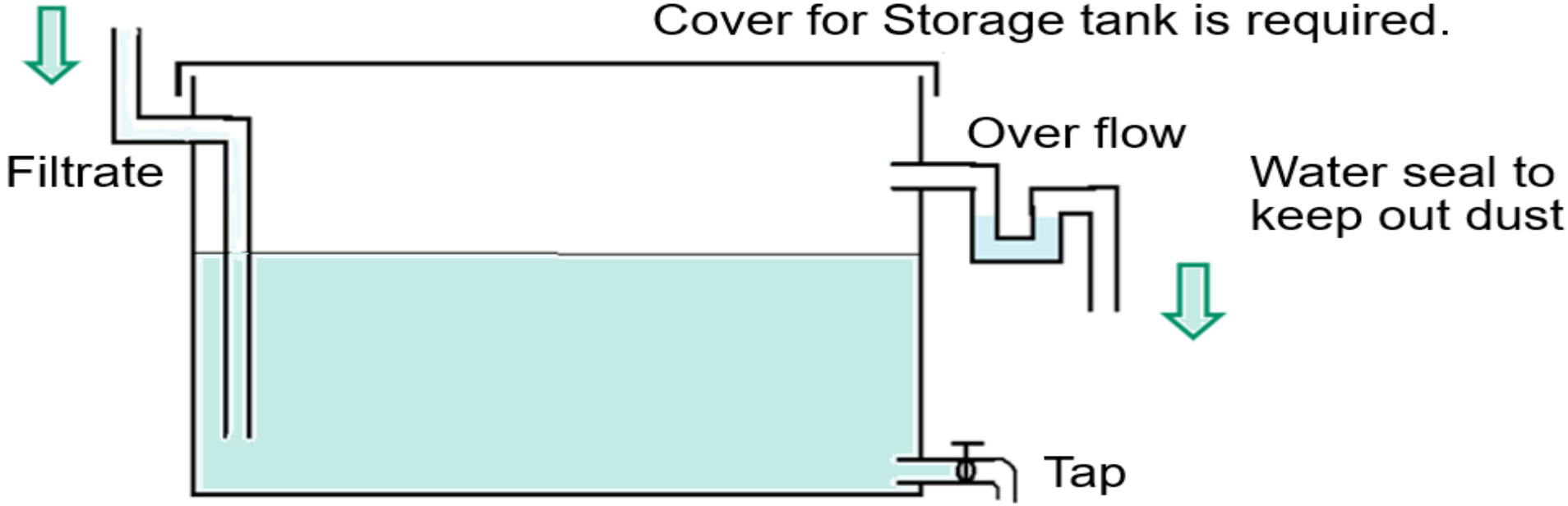
Mesh cover on a porous pipe

Biological active layer is only surface and thin layer beneath the surface.

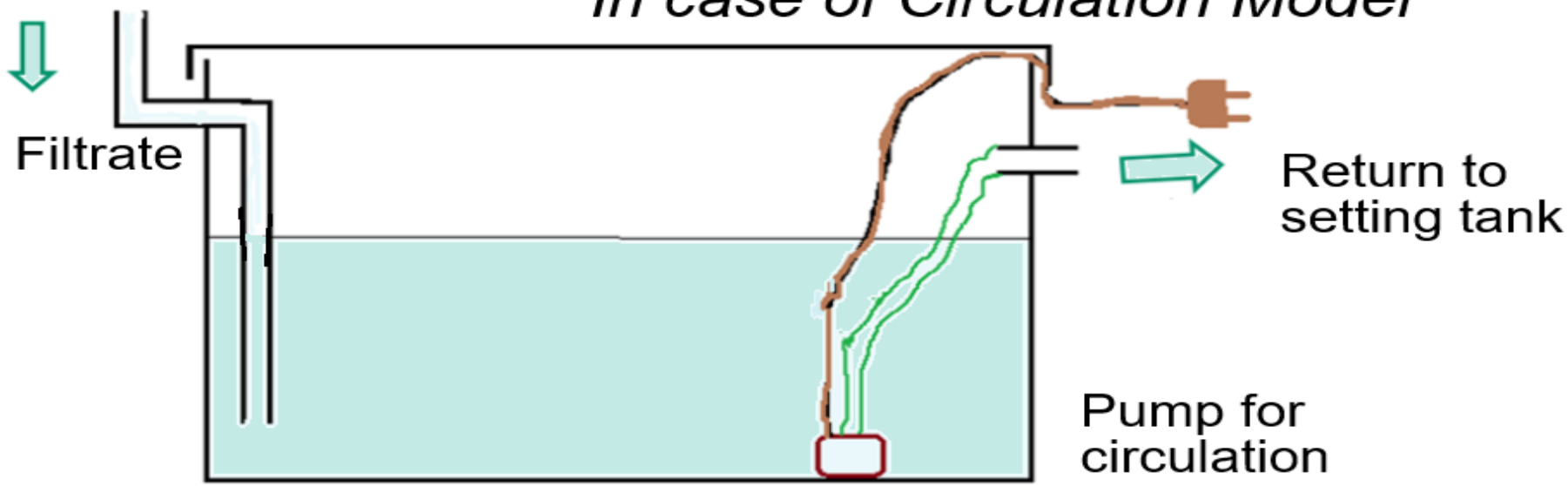


Algae and animals grow well on and beneath the sand surface.
Deep sand layer is a guarantee layer for emergency.

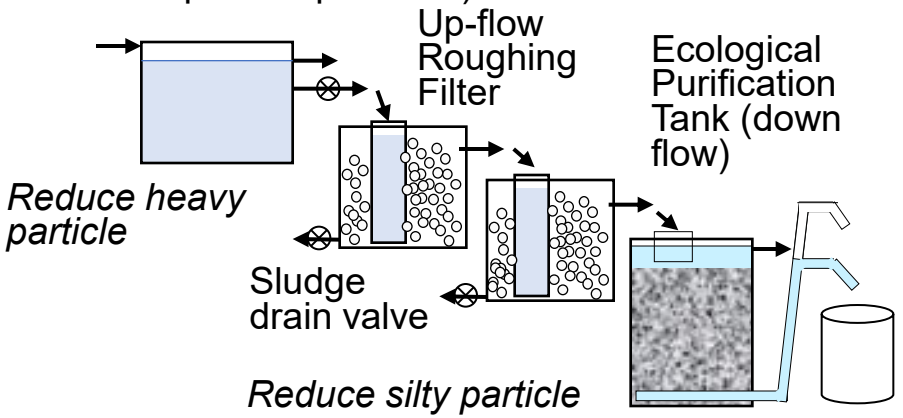
Storage (Filtrate) Tank



In case of Circulation Model



Raw water　Settling box
(over flow to keep water pressure)



Filter area = 26.5 cm x 40 cm = 1,060 cm2

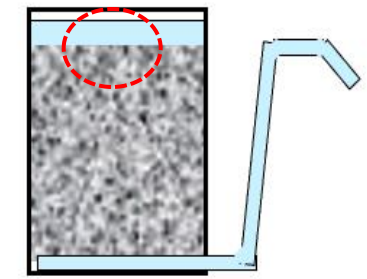
In case of Present Thames filter rate (40cm/h =9.6m/d)

Filtrate/min = 1,060 cm2 x 40 cm/h/ 60 (min) =707 cm3(ml)/min

Filtrate/h = 1,060 cm2 x 40 cm/h = 42,400 cm3/h =42.4 liter/h

Filtrate/d = 42.4 liter x 24 hrs = **1.02 m3/d**

Filter rate can be measured using a cup and is regulated by a cock.



Shallow water depth over sand is important to keep aerobic condition.

Passing time of water is shorter in shallower depth.
And higher flow rate is also better to keep aerobic condition.

	unit	Simpson 1829	English Filter	Present Thames Filter	Experiment in Samoa
Flow rate	m/d	2	4.8	9.6	20
	cm/h	8.3	20	40	83
Flow rate in sand layer (50% porosity)	cm/h	16.7	40	80	167
Passing time of 1 m sand layer	hr	6	2.5	1.25	0.6
Passing time of upper active 1 cm	min	3.6	1.5	0.75	0.36

I studied on ecological function of Miyako-jima wks. I made a video on EPS function of Miyako wks in March 2004 and published a book in August 2005.

JICA training started in 2006.

JICA made Video in 2008

Slow sand filtration: creating clean, safe water(Full ver) in 2020　25min56sec

https://www.youtube.com/watch?v=V6_uDZE_l8E&t=1218s

Quest for Safe and Delicious Tap Water, Miyako-jima, Island in March 2004. /15:22
With English subtitle version in Oct. 2007.

https://www.youtube.com/watch?v=r1LlPuQliu0&t=16s

Ecological Purification System : JICA training for SIWA, April 18, 2013

https://www.youtube.com/watch?v=NCI9oeNM0aI

Slow sand filtration: (Digest ver) in 2021　3min26sec

https://www.youtube.com/watch?v=QAH1SoAgfL0&t=37s

JICA Training on Ecological Purification System (EPS) in Okinawa, Japan in 2022

DIY EPS bucket model making 2022 - YouTube / 38:01

https://www.youtube.com/watch?v=jz94KFkLL3E

NGO Okinawa Blue Water

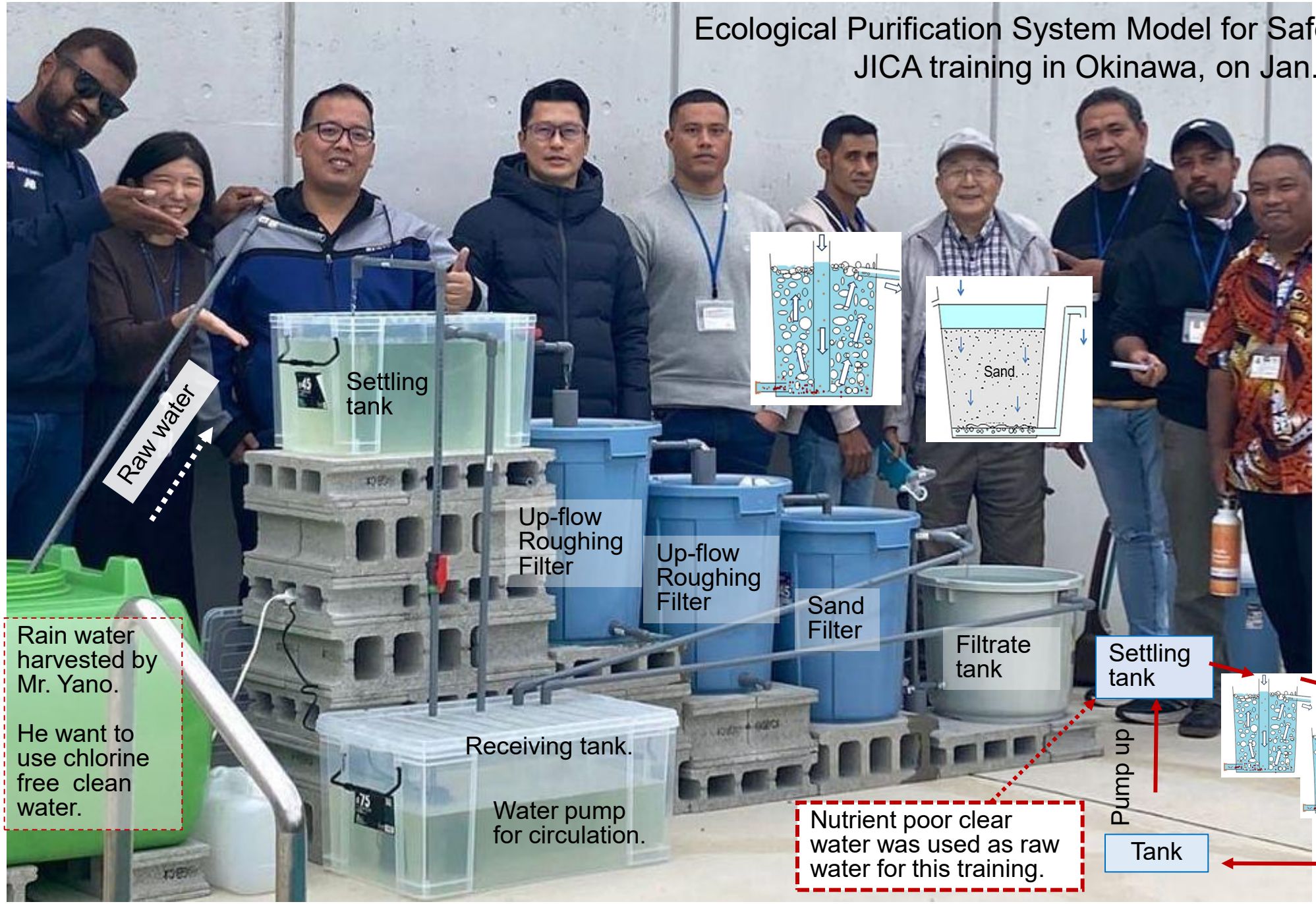
Un sistema ecológico, económico y replicable que puede ser utilizado por pequeñas, medianas y grandes comunidades. Este sistema fue desarrollado por el Doctor Nobutada Nakamoto

Ecological Purification System

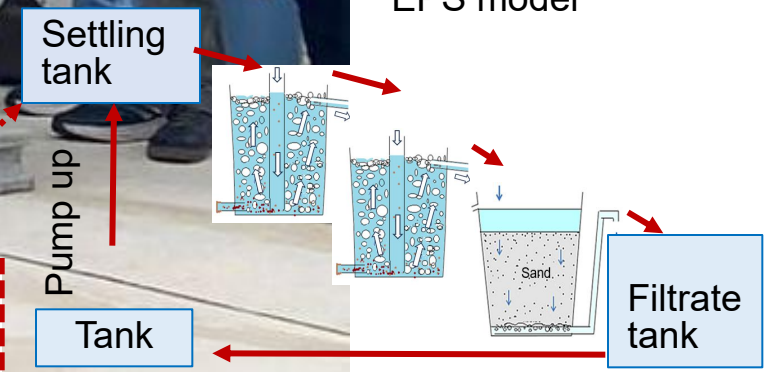
Daniel Castro
2017/07/20 に公開

https://www.youtube.com/watch?v=Ye-POV6qBU0&t=39s

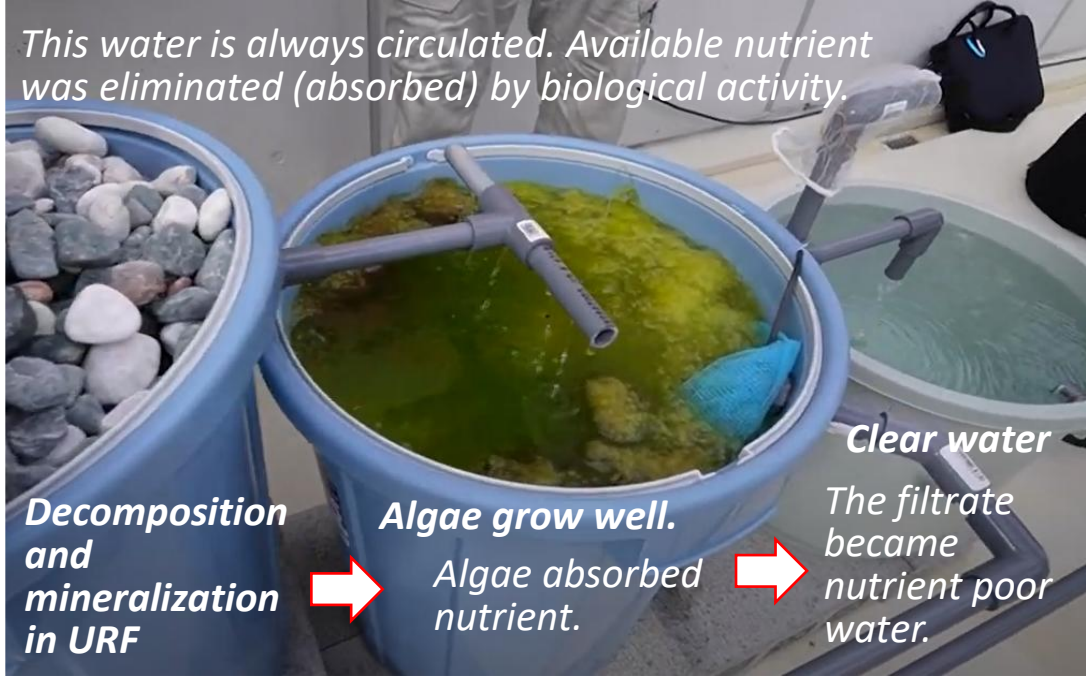
Ecological Purification System Model for Safe Drinking Water
JICA training in Okinawa, on Jan. 16. 2024.



Water circulation
EPS model



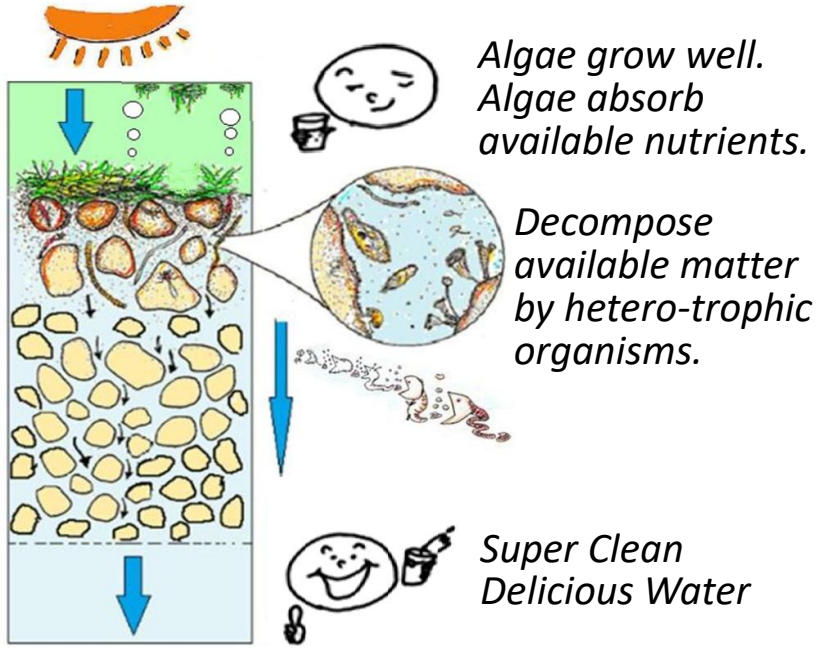
After 3 weeks, they enjoyed delicious super clean water.



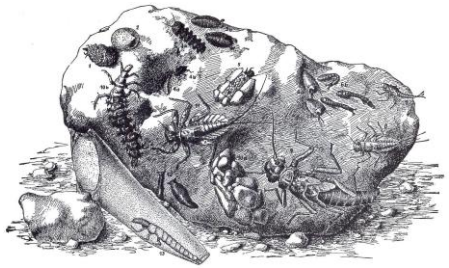
Filtrate Water that is free of substances that living things can react with.
It's water that tastes delicious and sweet.

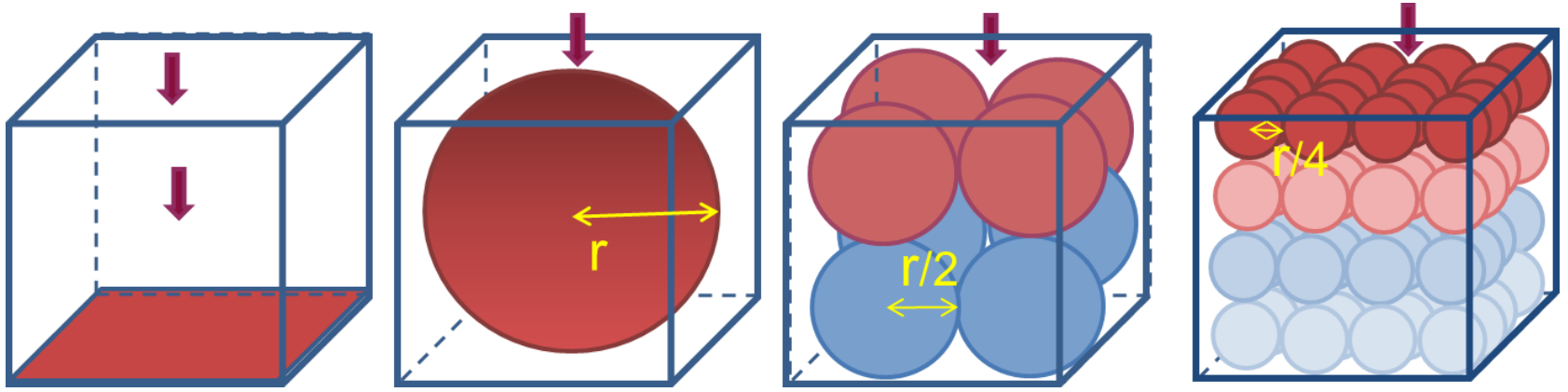
https://www.youtube.com/watch?v=RJLgf63s5Og

Sweet drop (honey dew)
Natural sweet and delicious water



Most of small organisms live on the surface of substrata (sand particle) under slow current condition. They live at the top of sand layer where food comes. They are always waiting for food. They are hungry.





1
Bottom surface area

radius = 0.5
Surface area
= 4 x π x r x r

radius = 0.25
Surface area of one ball
= 0.785
8 balls in box = ***6.28***
Total area of top 4 balls

radius= 0.125
One ball area
= 0.196
64 balls in box =***12.56***
Total area of top 16 balls

Too small particle becomes a flat surface.

1 → ***= 3.14*** → ***= 3.14*** → ***= 3.14***

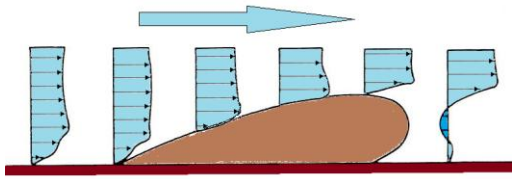
Surface area of a ball is 3.14 times than flat area.

Total surface area of top layer of balls is always same of 3.14 times than flat area.
Smaller ball makes larger area.

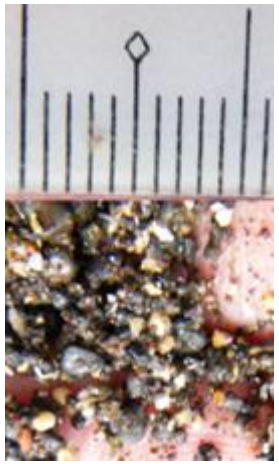
And, total volume of balls is always same of 52 % (porosity : 48%) in a box.

Filter resistance increases toward smaller size of particle.

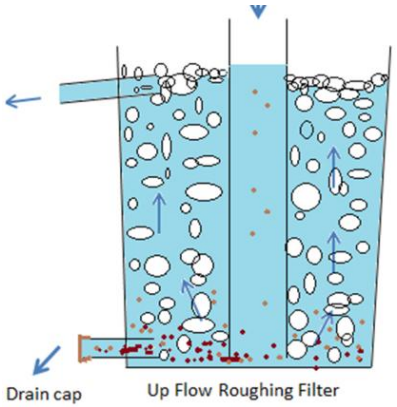
Viscosity relates to temperature



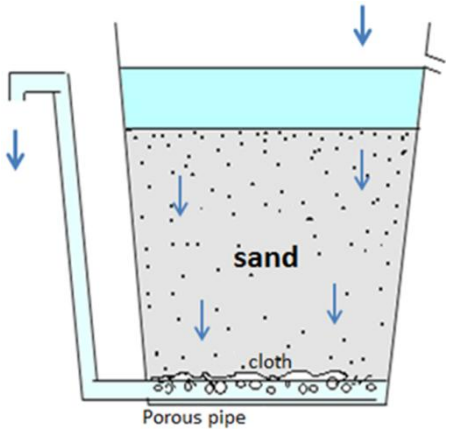
Points: shallow depth, enough radiation on the bottom, rapid growth, large size of sand.

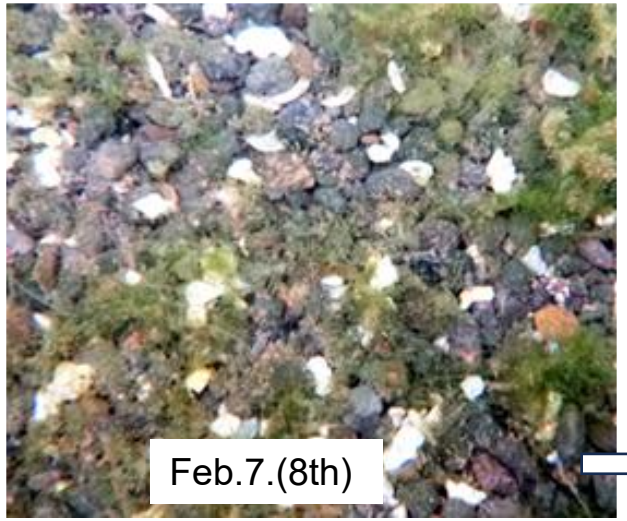


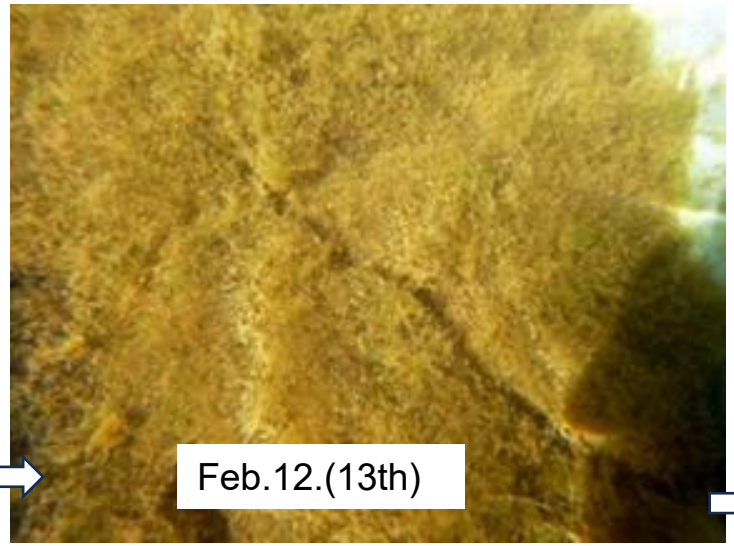
Sand separated with mosquito mesh (1-2 mm)



Two up-flow roughing filters







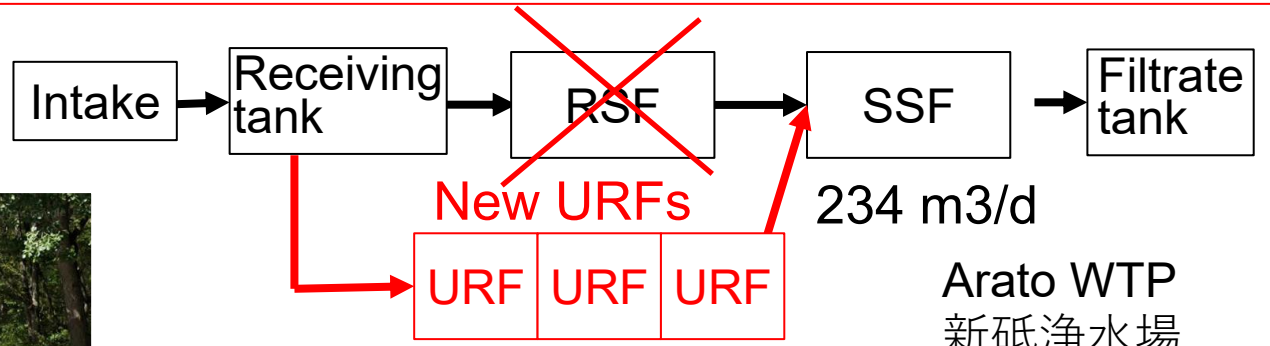
Sand filters (5m/d, 10m/d, 20m/d) All good filtrates.

Shallow depth: Algae grow well.

URF Effect : Reduce scrape works after introduce URF.

Mr. K. SANDA informed me his wonderful result on URF.

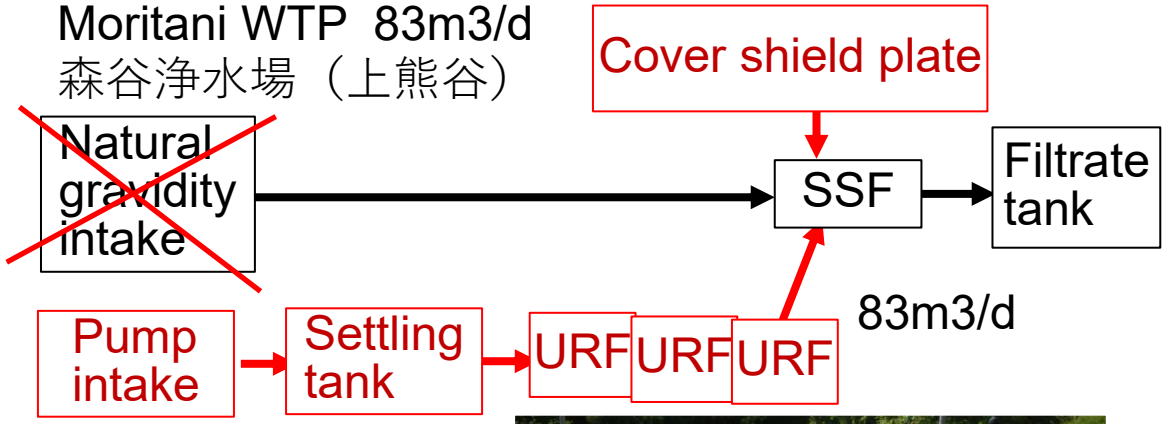
To prevent clogging of the slow sand filter (SSF) and to reduce turbidity, a rapid sand filter (RSF) was installed. This RSF was removed and a new 3-step URF was installed.



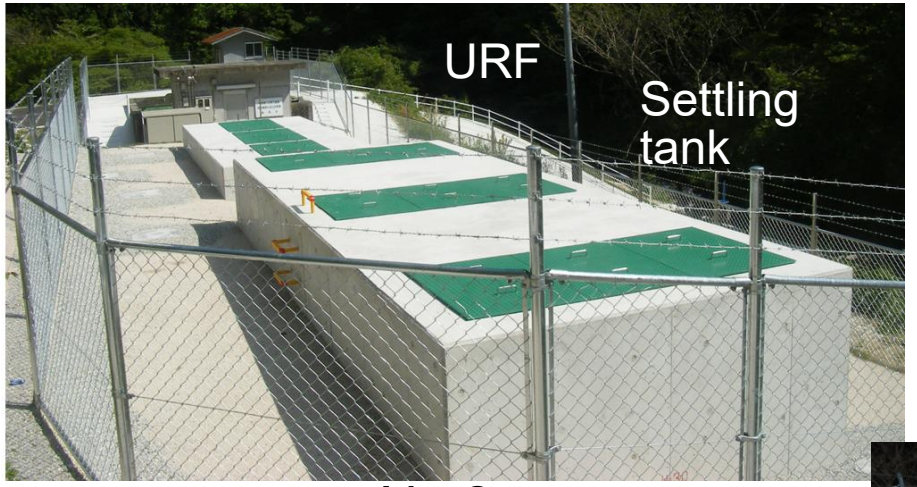
Inside URF

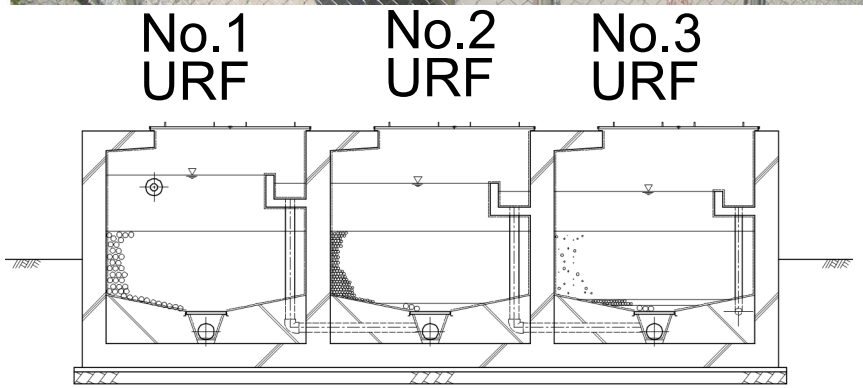
RSF

To prevent clogging of the slow sand filter (SSF), the water intake method was changed from natural gravity flow to pump intake, and a conventional settling tank and three stages of upward flow coarse filter (URF) were newly installed before the existing slow sand filter. To reduce the frequency of SSF erosion, a float-type light-shielding plate was installed in the slow sand filter (SSF).

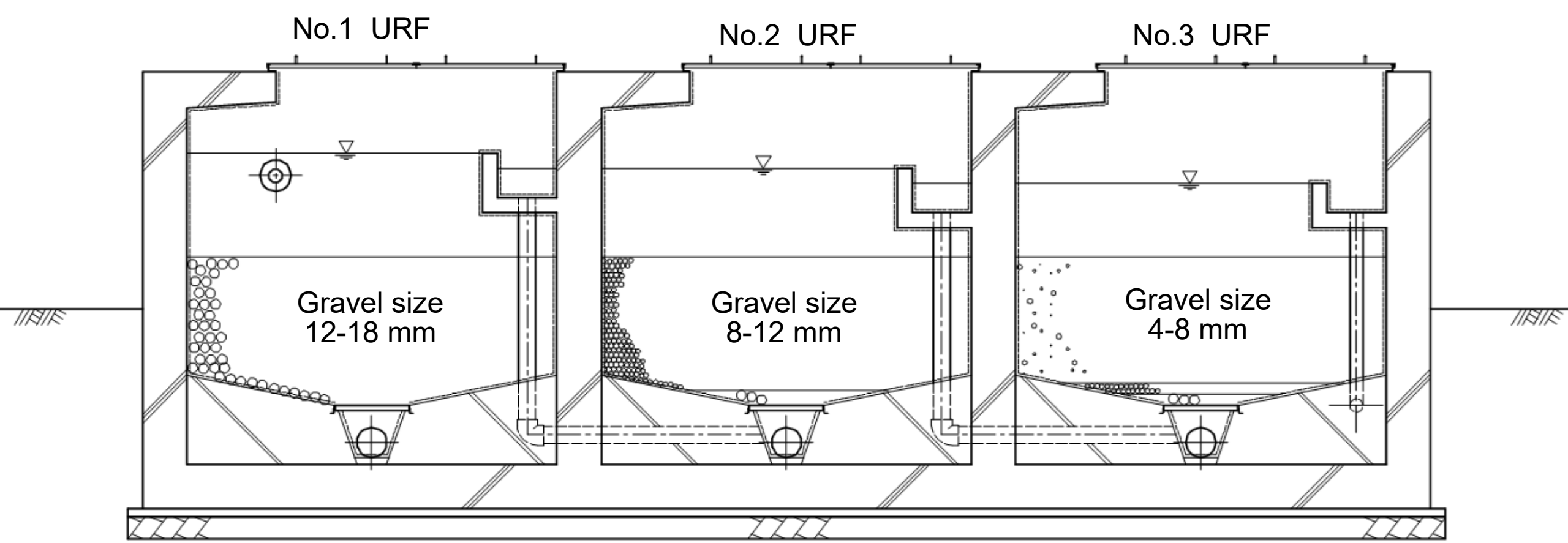


The inflowing river water quickly turns into muddy water after rainfall.





Three steps of URF with different size of small gravel.



Management of the URF is simple, requiring only the opening and closing of a sludge discharge valve, and the draining process takes **only about 5 minutes per filter**, thus minimizing the time spent on maintenance. Drain of the settling tank is also the same.

The slow sand filter (SSF) requires less frequent scraping, thus reducing the manpower needed for scraping.

No.1 URF after 1 year

No.1 URF after 3 years

No.1 URF after 10 years

Drain off of accumulated mud in No.1 URF was not done during 10 years after the construction (in 2015).

However, Mr. SANDA noticed thick accumulated mud on the surface gravel layer of No.1 URF.
Then, he tried the drain off mud using the drain valve.

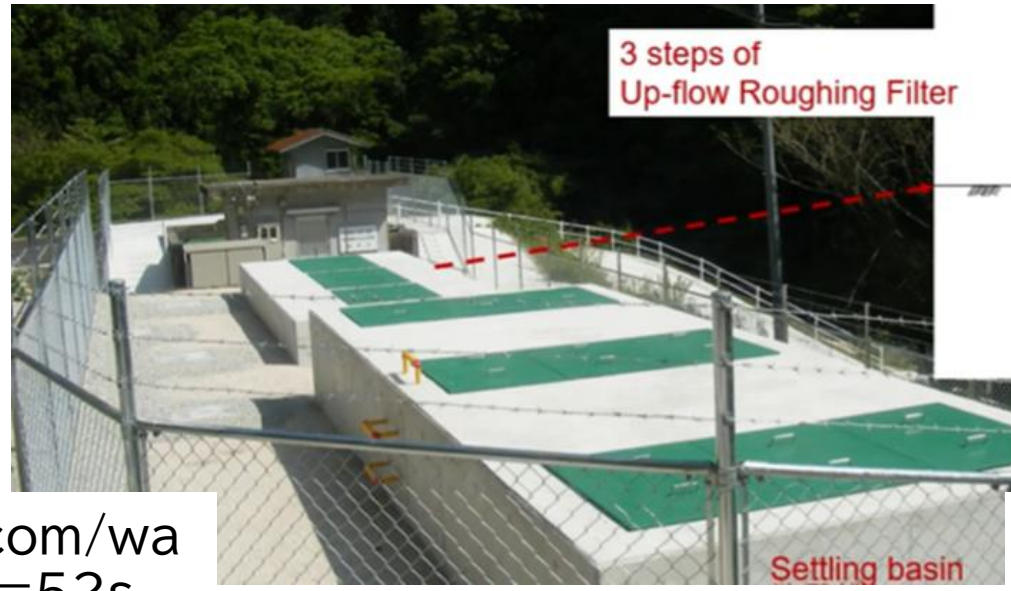
No.1 URF after 3 years in winter time

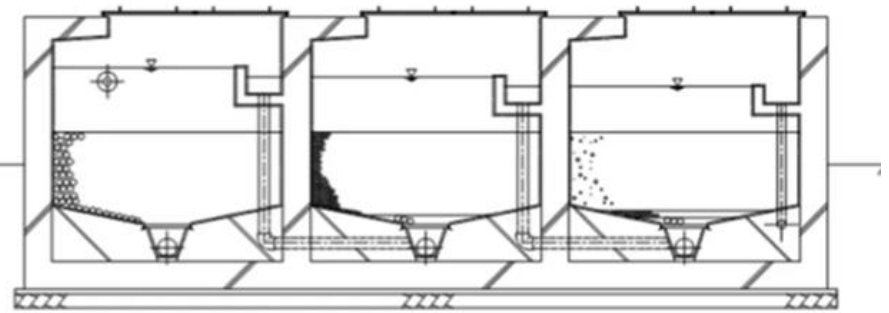
No.1 URF after 10 years was covered with mud on the gravel surface.

https://www.youtube.com/watch?v=3lytpVhzdsQ&t=52s

English with Jap.
10min 33sec

Mr. SANDA found an interesting phenomena in this system. He took them in his video and sent me. Please watch this video.

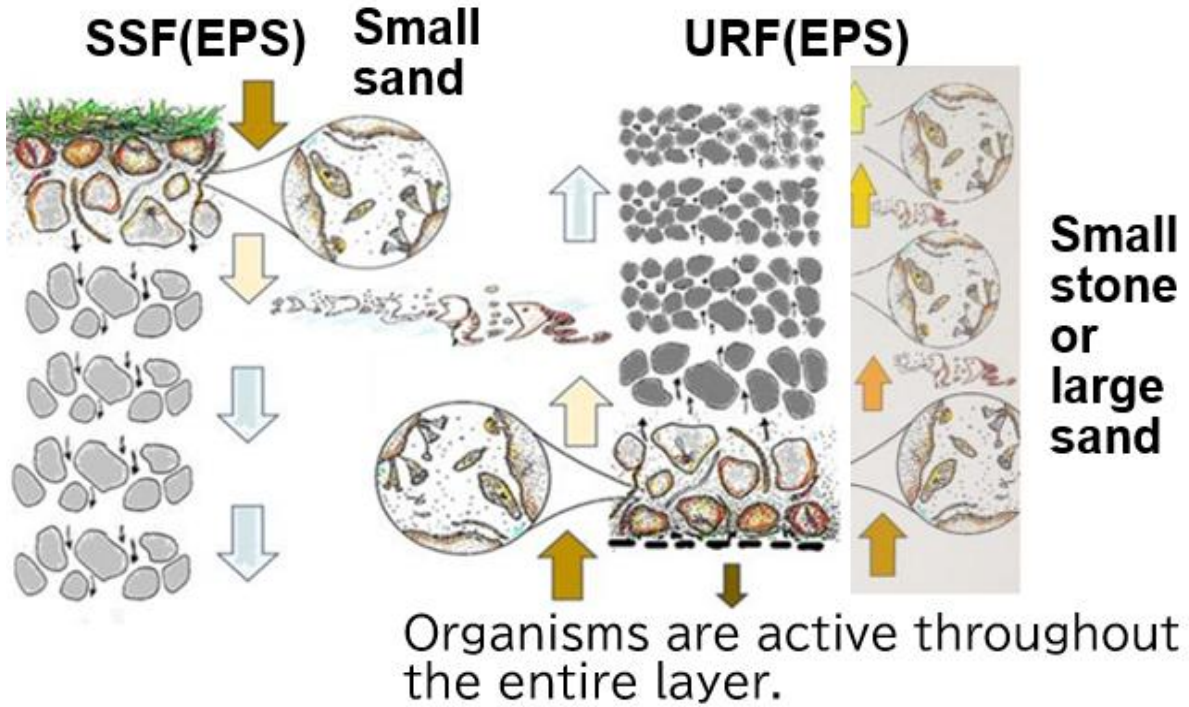




Gravel size of URF粗ろ過礫の粒径

No. 1.	No. 2.	No. 3.
12-18 mm	8-12 mm	8-4 mm

上向流粗ろ過の排泥
第１槽：未実施(2015年から10年間)
No.1 URF: Never drain off from 2015 (10 yrs.)
第２槽：2015年から2回実施
No.2：2 times during 10 yrs, from 2015.
第３槽：年に1回の頻度で実施
No.3：Once per year.



Accumulated mud on the gravel layer.

Collection of accumulated mud.