Miyako-jima, Okinawa: Nov.12-16. , 2007

Safe and Reliable Drinking Water by the Biological Filter of Slow Sand Filtration

Ecological Purification System

New Concept of Slow Sand Filtration System

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Refocusing, Rediscovery, Timeless Technology for Modern Application

1804: Public Water Supply at Paisley, Scotland. An artificial subsurface water by passing through the gravel and sand boxes.

1829: Slow sand filtration system as English filter was completed at London. Safe drinking water for pathogen.

1885: Chemical treatment using coagulant reagent in New Jersey, USA.

1910: Sterilization by chlorine gas in New Jersey.

1974: Consumer report on tri-halo-methane compounds by chlorine.

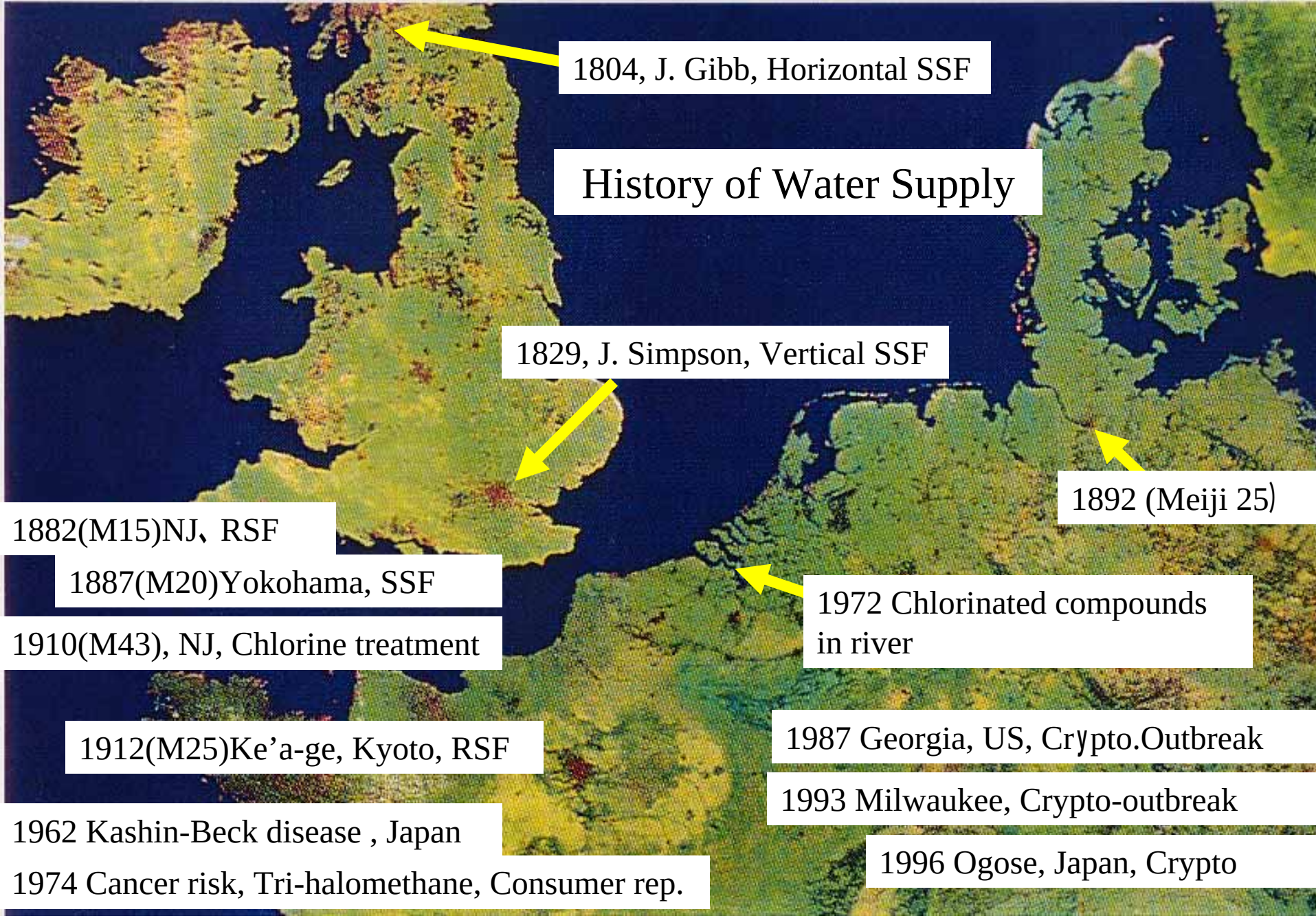
1993: A large outbreak of diarrhea was occurred in Milwaukee, USA.

Slow sand filtration system was refocused as more safe system than chemical treatment. Rediscovery, Timeless technology.

1983: Nakamoto found an important role of algae and an ecological point of biological community on SSF at Ueda city, Japan.

Refocusing, Rediscovery, Timeless Technology for Modern Application

Water Supply for entire city was constructed in 1804 at Paisley, Scotland. This water was made by passing through the gravel and sand boxes. Slow sand filtration system to make safe drinking water was completed in London, 1829. This system was almost same as present slow sand filter system. By this system, germ cells of pathogen were almost completely eliminated. This system was distributed in the world as an English filter. Chemical treatment using coagulant reagent to reduce suspended matter in river water was invented in New Jersey, USA, in 1885. In 1910, chlorine gas was used to kill the bacteria in filtrate water in New Jersey. This was also accepted as new technology of American filter. In 1974, consumer report was issued that tri-halo-methane compounds was formed the process of addition of chlorine. A large outbreak of diarrhea was occurred in Milwaukee, USA, in 1993. Slow sand filtration system was refocused as more safe system than chemical treatment. I (Nakamoto) found an important role of algae in SSF at Ueda city, Japan in 1983. After that, I researched for safe water by SSF.



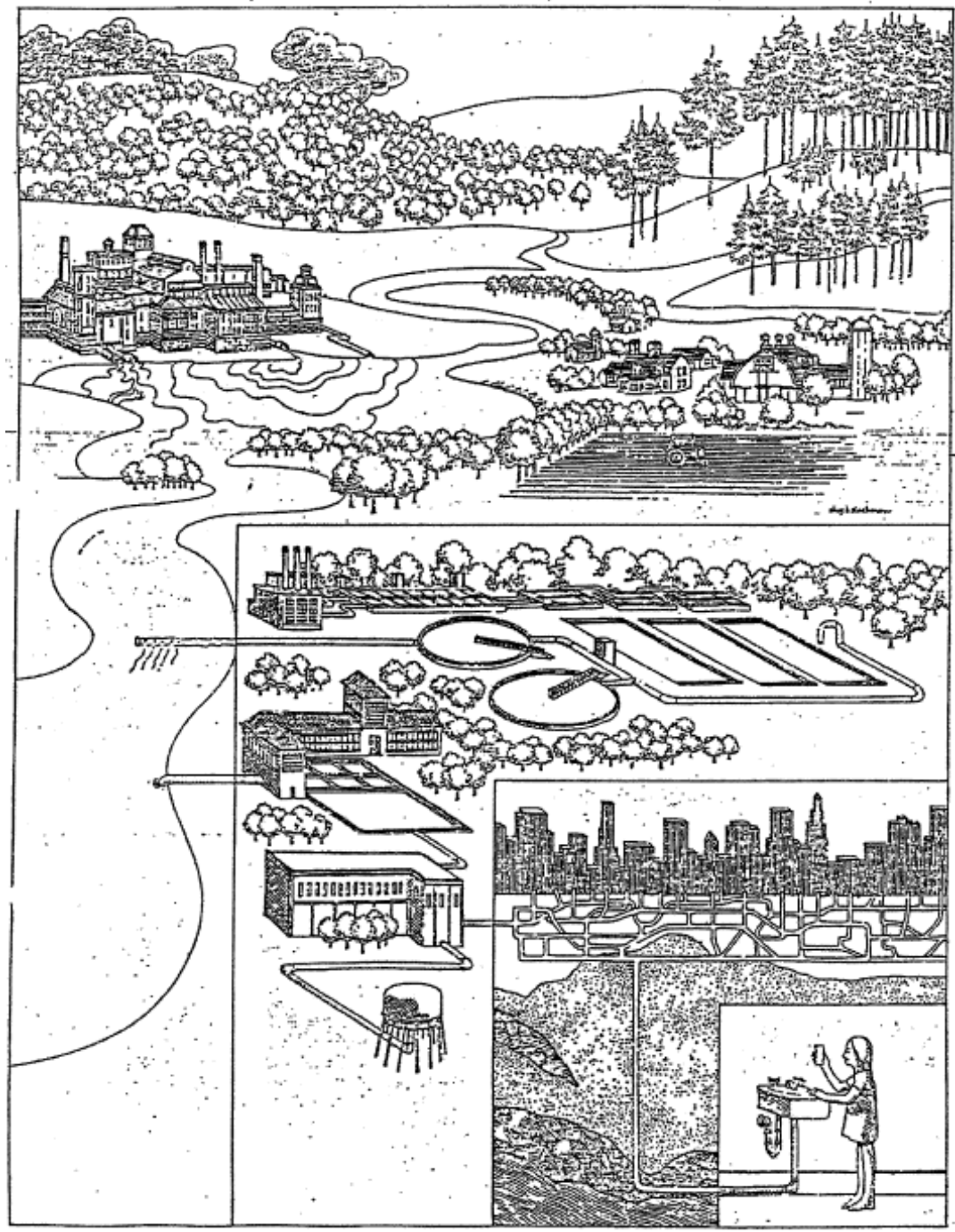
SSF →Safe water (epidemic disease)→RSF+Cl→Tri-halomethan→Membrane

IS THE WATER SAFE TO DRINK?

By Robert H. Harris and Edward M. Brecher
and the Editors of Consumer Reports

PART 1: THE PROBLEM

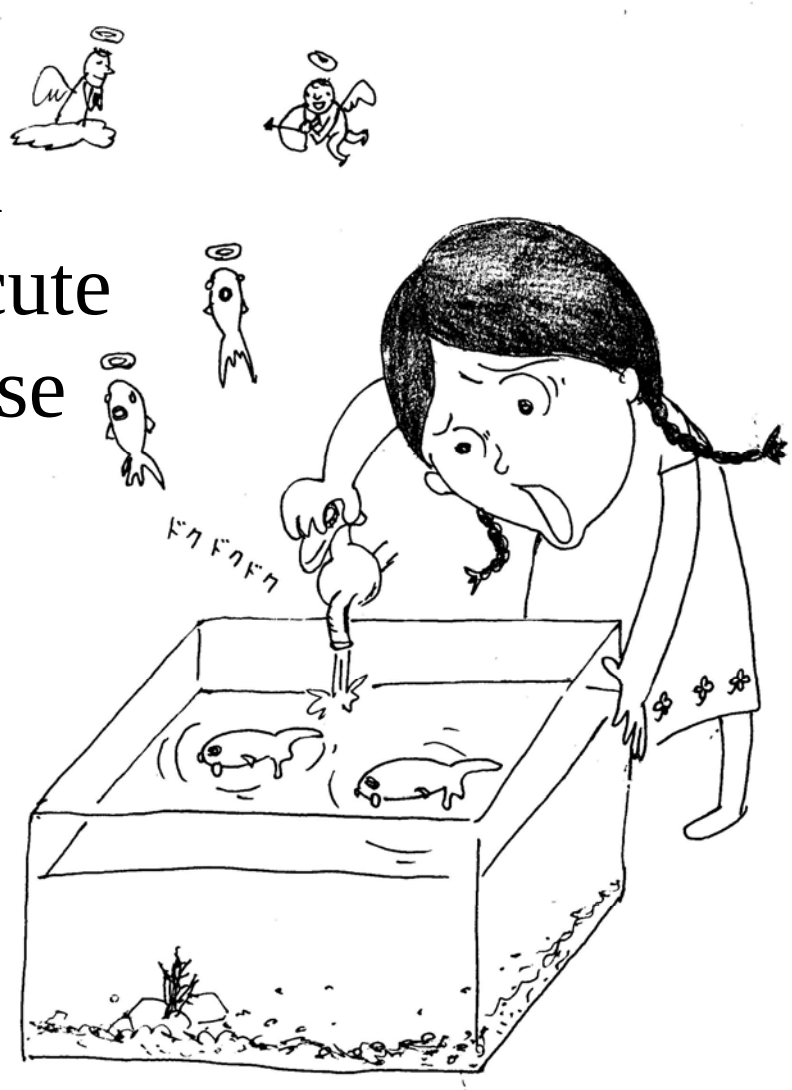
Robert H. Harris and Edward M. Brecher and the Editors of Consumer Reports
Consumer Reports 1974.June：436-443：
Part 1:The Problem:
New Orleans, like many other American cities, gets its drinking water from a heavily polluted source – the Mississippi River. Many industries discharge their wastes into the river, and many upriver cities discharge their sewage into it. The rainwater runoff from farmland carries a wide variety of pesticides, herbicides, fertilizers, and other agricultural chemicals that swell the Mississippi's pollution burdens.
Asbestos in the water :Temporizing with cancer.
Bacteria, Viruses, Heavy metals, Organic compounds, Hazards after the treatment.
July:538-542：How to make it safer
August:623-627：What you can do



Are YOU sure this water is safe?

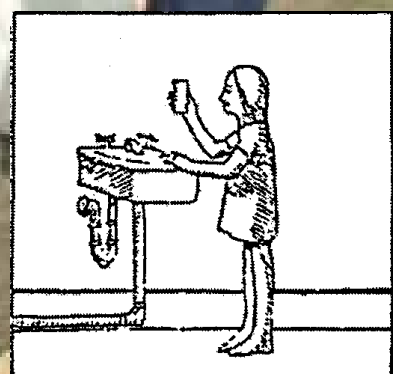
Fish is killed by chlorinated water. This water has not acute toxicity for human in the case of low level of chlorination. However it may get into chronic illness.

People loves bottled water. People does not trust chlorinated water. People response instinctively



People prefer to drink natural spring water.

People does not like chlorinated tap water.



Is this water is safe? Harris 1974

This water is not guarantied by the authority. However people trusts this natural water.

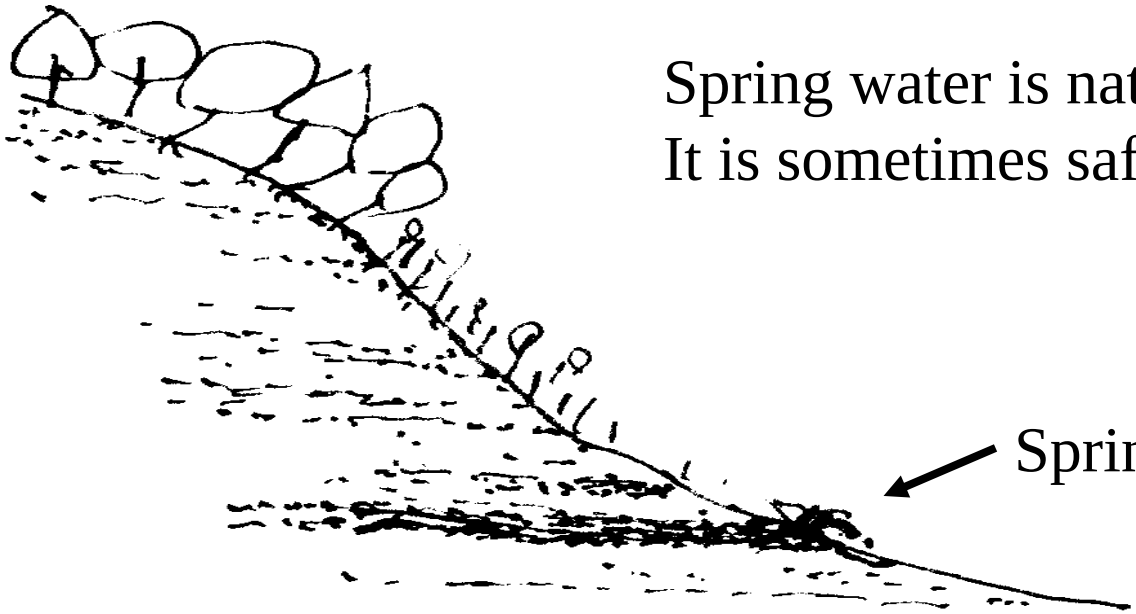
Waterworks: supply system for drinking water

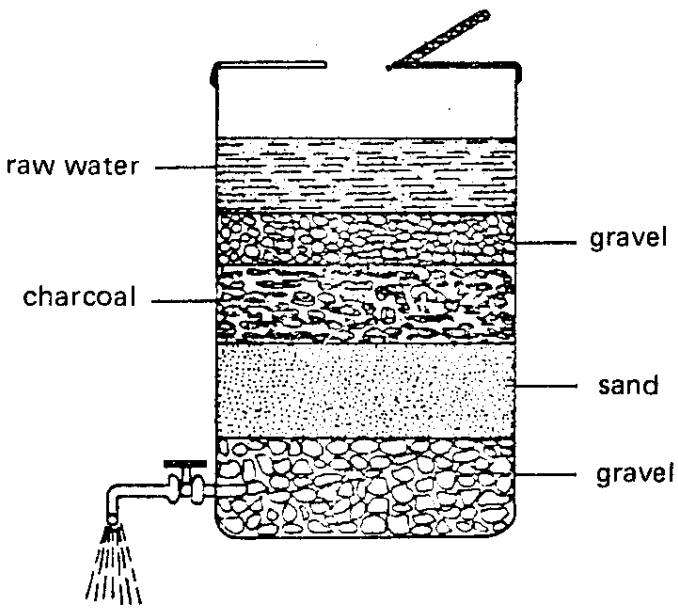
People loves bottled water (natural mineral water) instead of tap water.

Waterworks produce bottled water for drinking water. This water is de-chlorinated water.

Before world 2nd war, Japanese tap water was the high quality water which was treated by English filter. This quality was no change during long storage period.

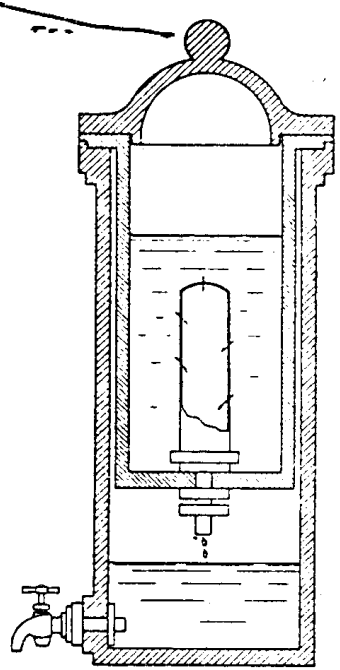
Spring water is natural filtered water.
It is sometimes safe to drink.





Heber 1985

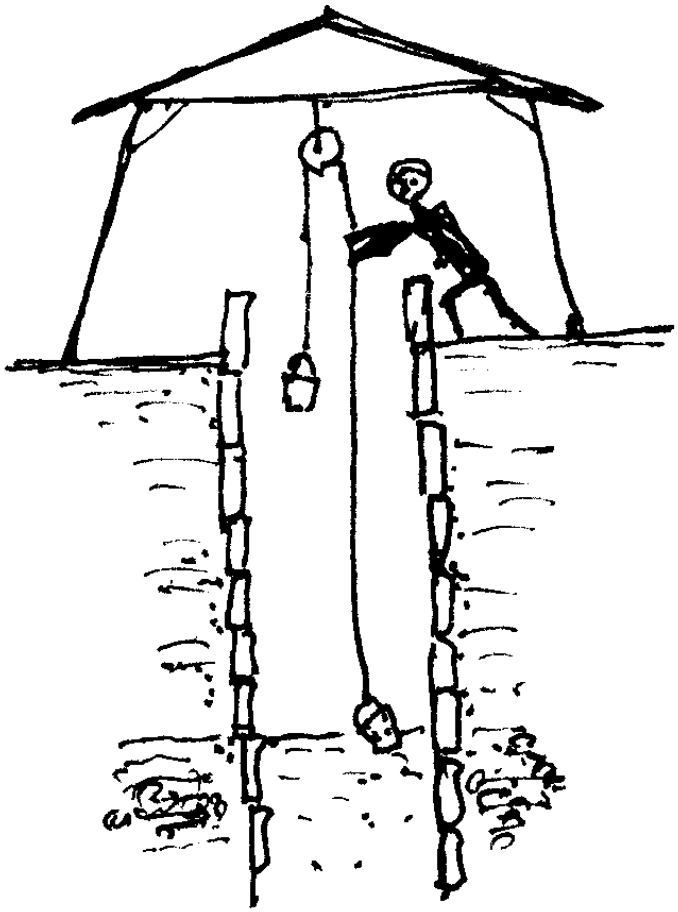
Multiple layer filter does not perform well at removing pathogens.

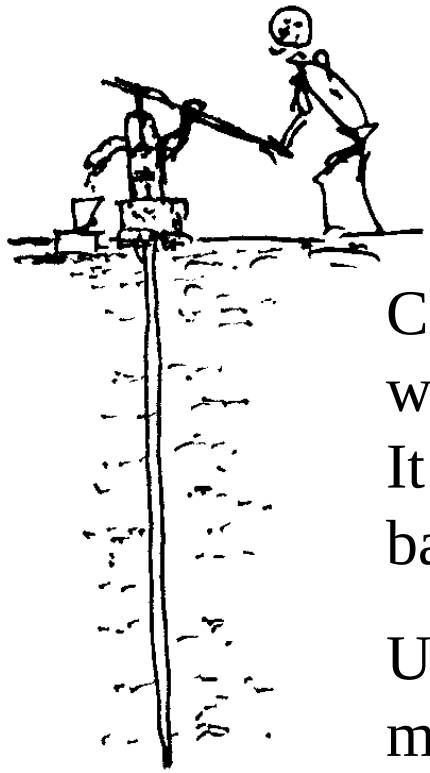


Heber 1985

Ceramic filter may be used for the purification of drinking water. If the pore size is smaller than 1.5 micron, all pathogens are removed.

Dugwell and tubewell waters are not always safe.



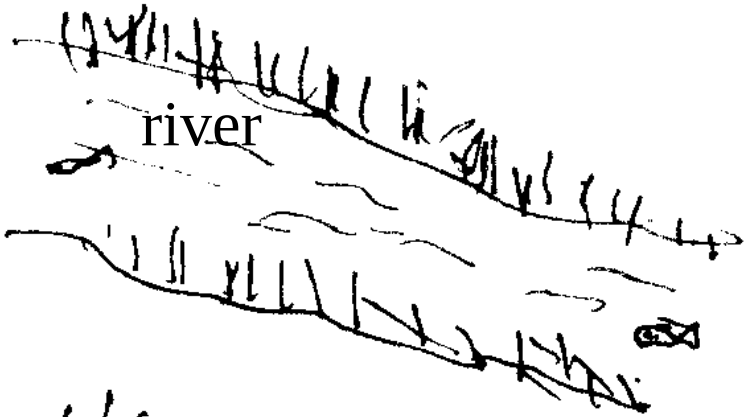


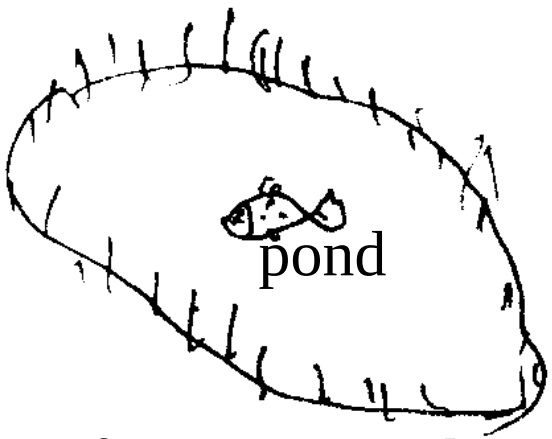
Clean underground water can be collected. It is usually free from bacterial contamination.

Undetectable heavy metal contamination is reported. However chronic patients appeared. There was chronic toxicity in this underground water.

Heavy metals are easily dissolved in underground water. This water contains small amount of dissolved oxygen.

Familiar surface waters are not always safe.

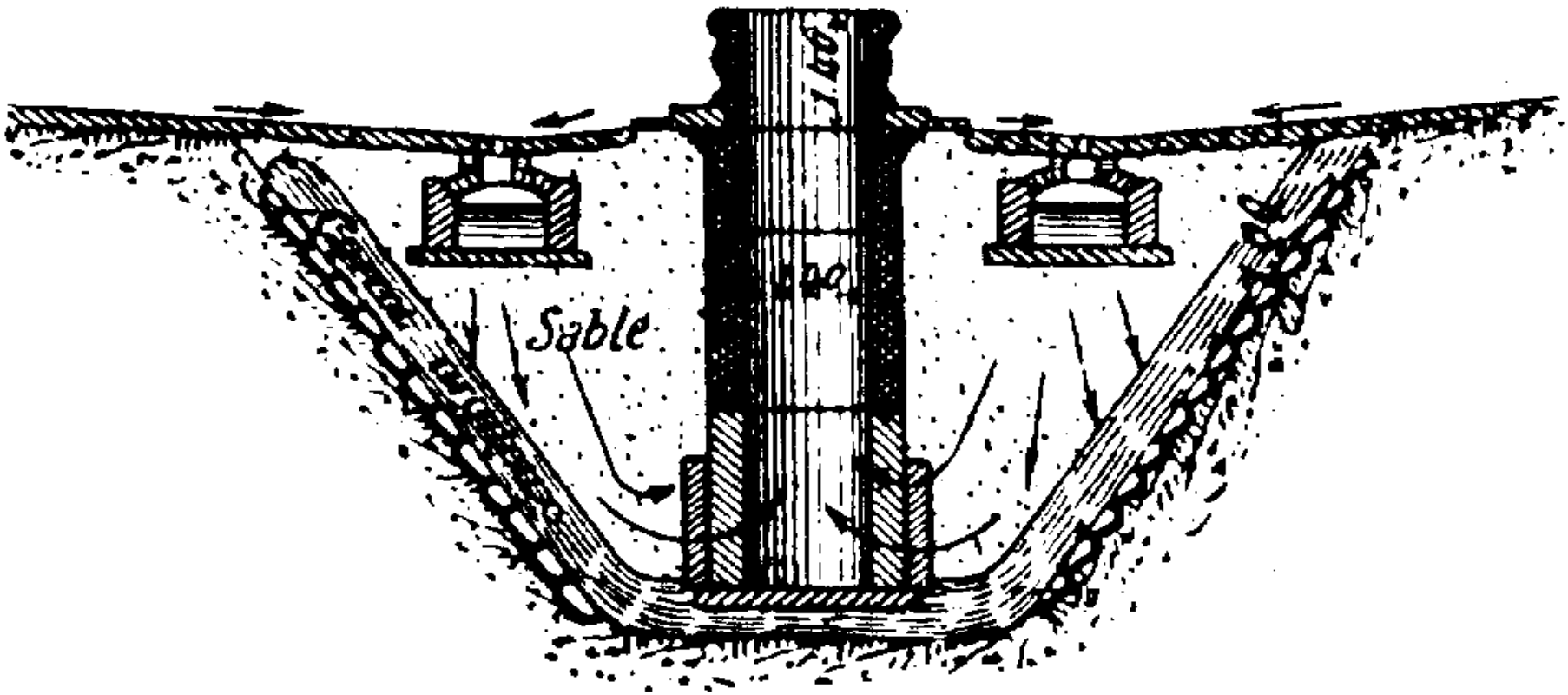




Surface water and stored rain water are easily contaminated by pathogens and other dangerous worms. These waters are not always safe to drink directly. However these water are safe level for heavy metal. Fish is an indicator of safe water.

Boiling is the best way against pathogens.

Venetian Filter, 16th century



This (natural safe filtered water) was originated
from clear seepage water in the flood plain of a river.

Baker 1949

Artificial subsurface water.

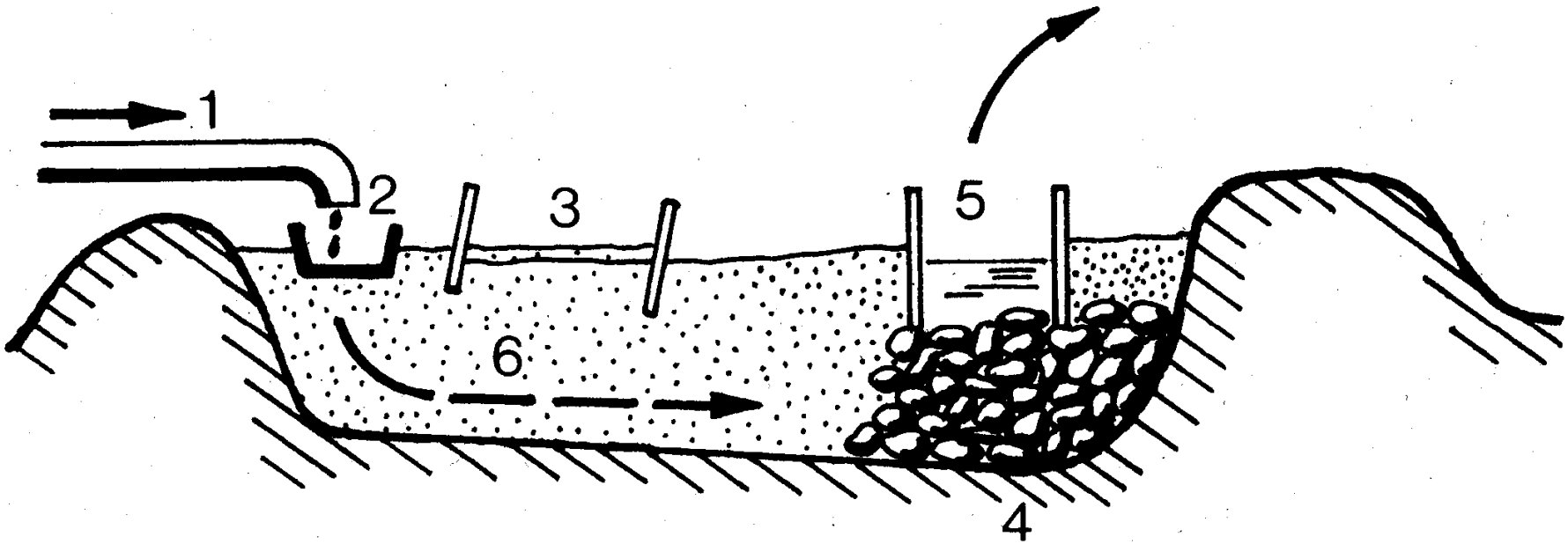
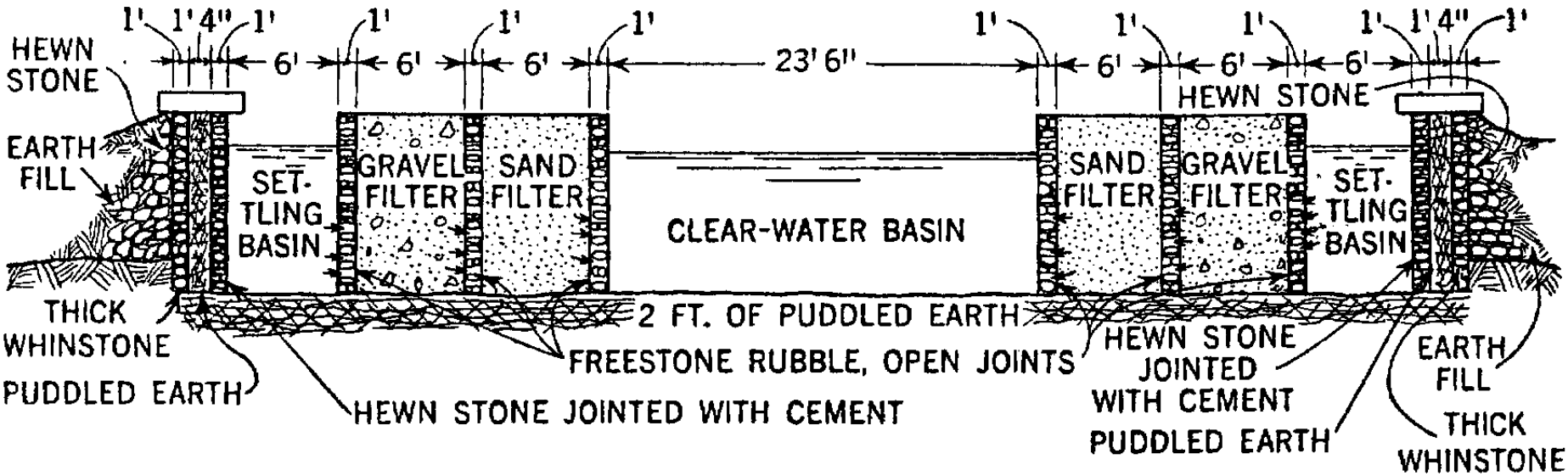


Fig. 27: Horizontal flow sand filter [46, 77, 81]. 1 Inlet pipe, 2 inlet trough to prevent scouring, 3 barriers, 4 gravel 50 mm, 5 outlet trough, 6 flow direction

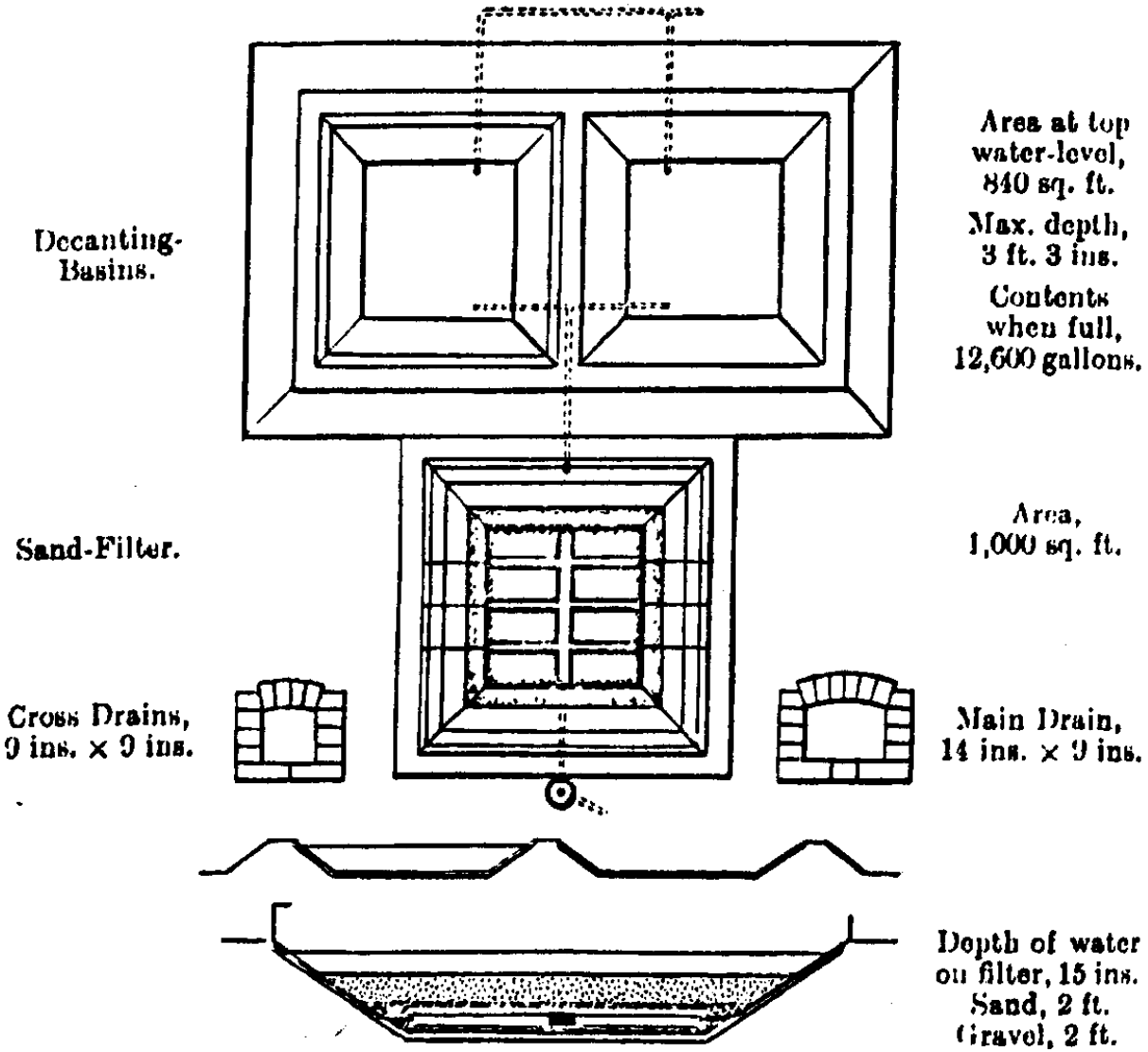
G. Heber 1985 Simple Methods for the Treatment of Drinking Water.

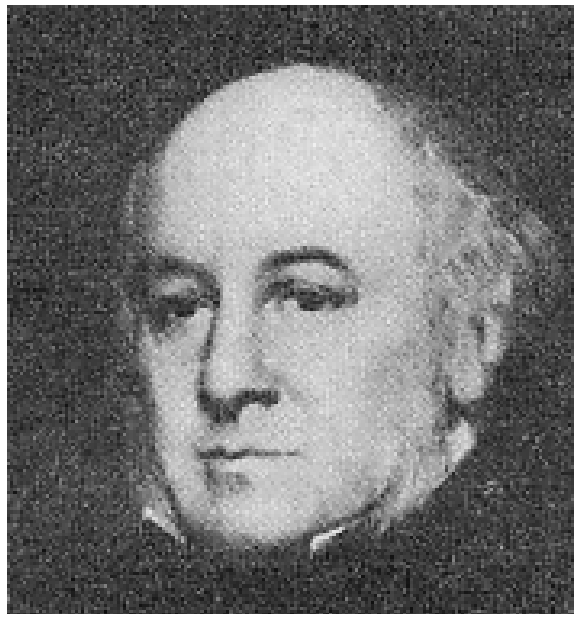
Seepage water in flood plain : clear water

Origin of Public Water Supply :
First known filter to supply an entire city with water, completed at Paisley, Scotland, in **1804**, by John Gibb.



Water passed through stone-filled trench to ring-shaped settling chamber, then through two lateral-flow filters to central clear-water chamber.



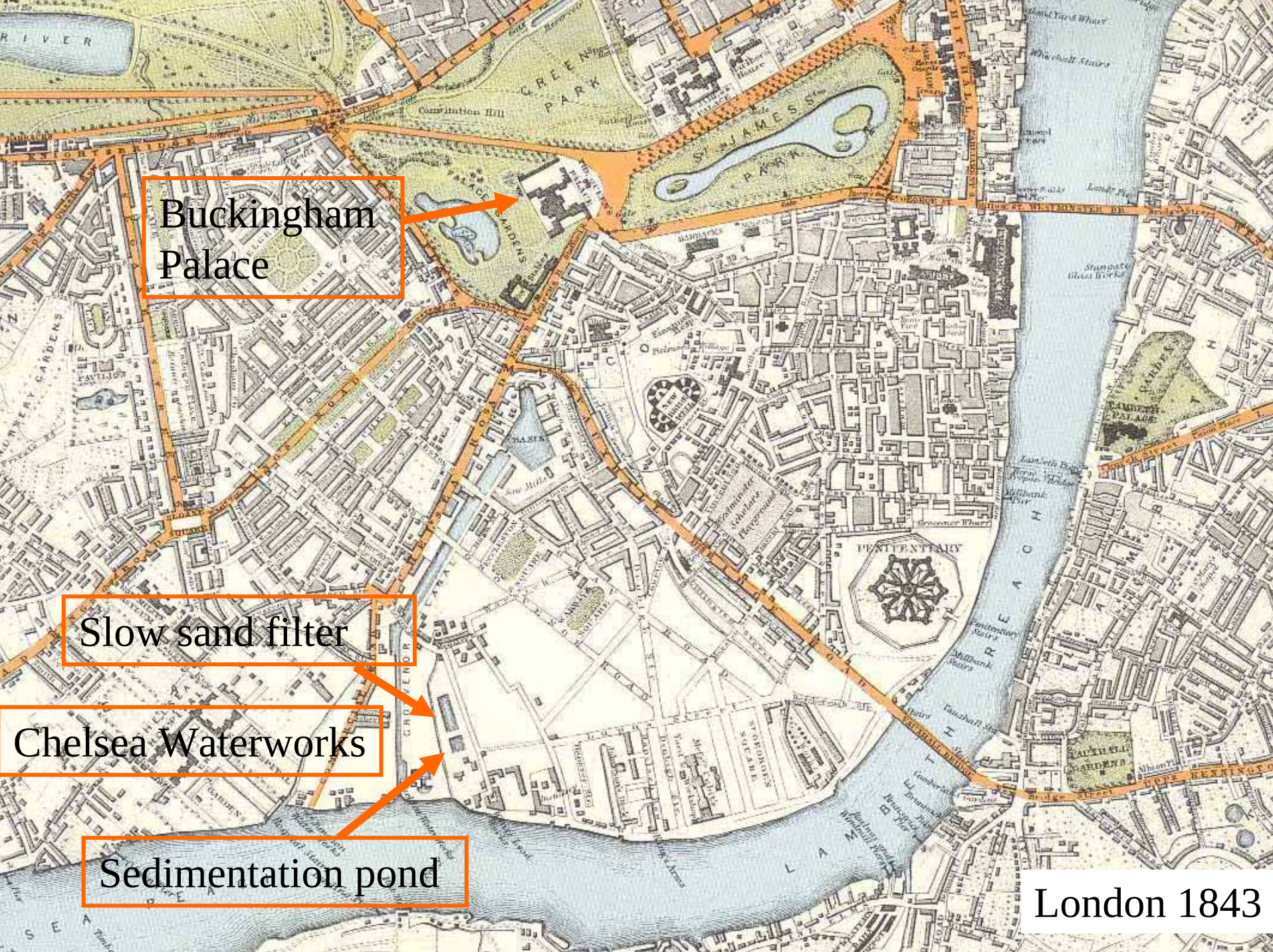


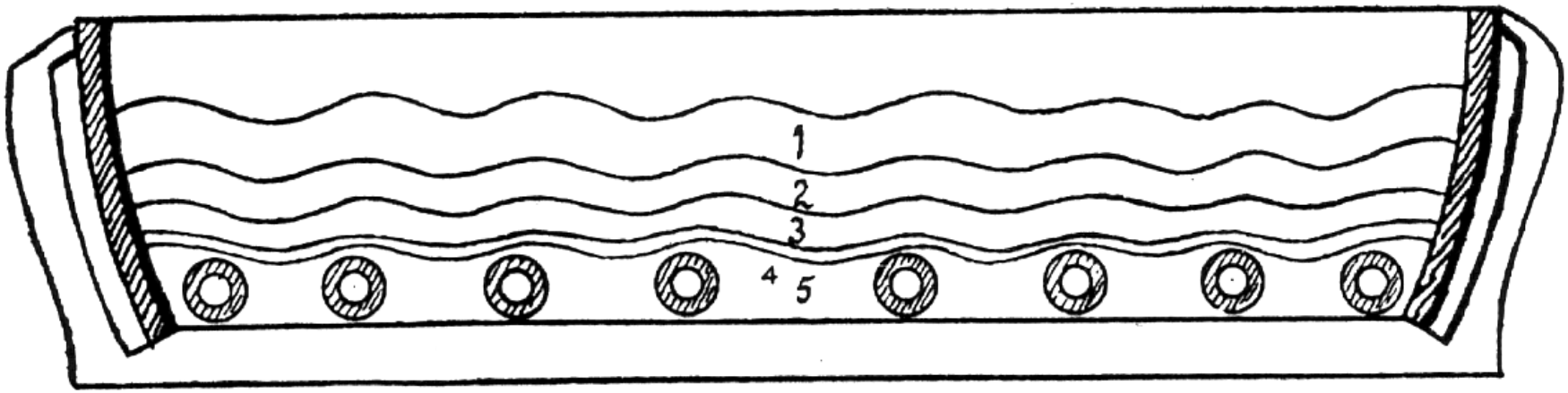
James Simpson 1799-1869

The experimental filter was continued in use at least eight months. The supply of water to the metropolis started on July 7, **1828**. London, UK.

James Simpson's Experimental Filter of 1827-28.

Baker 1949


Buckingham Palace
Slow sand filter
Chelsea Waterworks
Sedimentation pond
London 1843



Cross Section of Simpson's One –Acre Filter for Chelsea Water Works Co., **1829**.

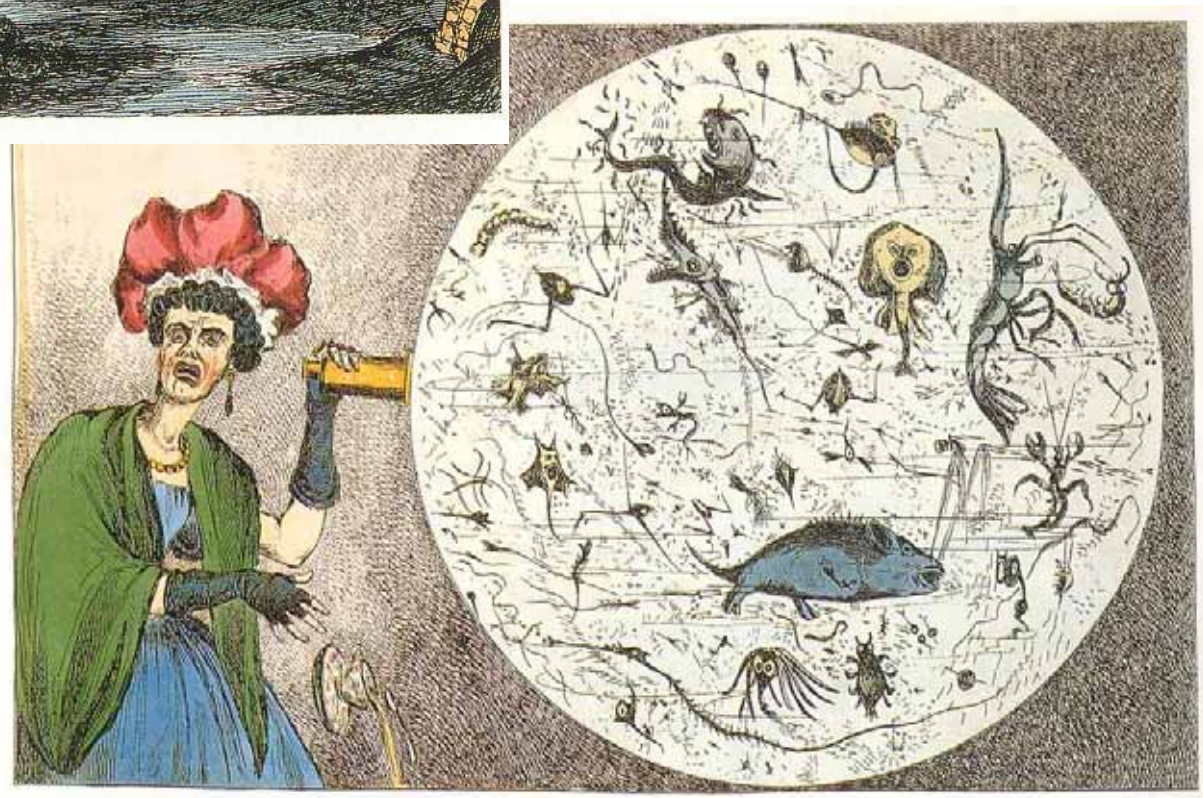
Media were: 1.fine sand; 2.loose sand; 3.pebbles and shells; 4.fine gravel; 5.large gravel, containing "brick tunnels" or underdrains.

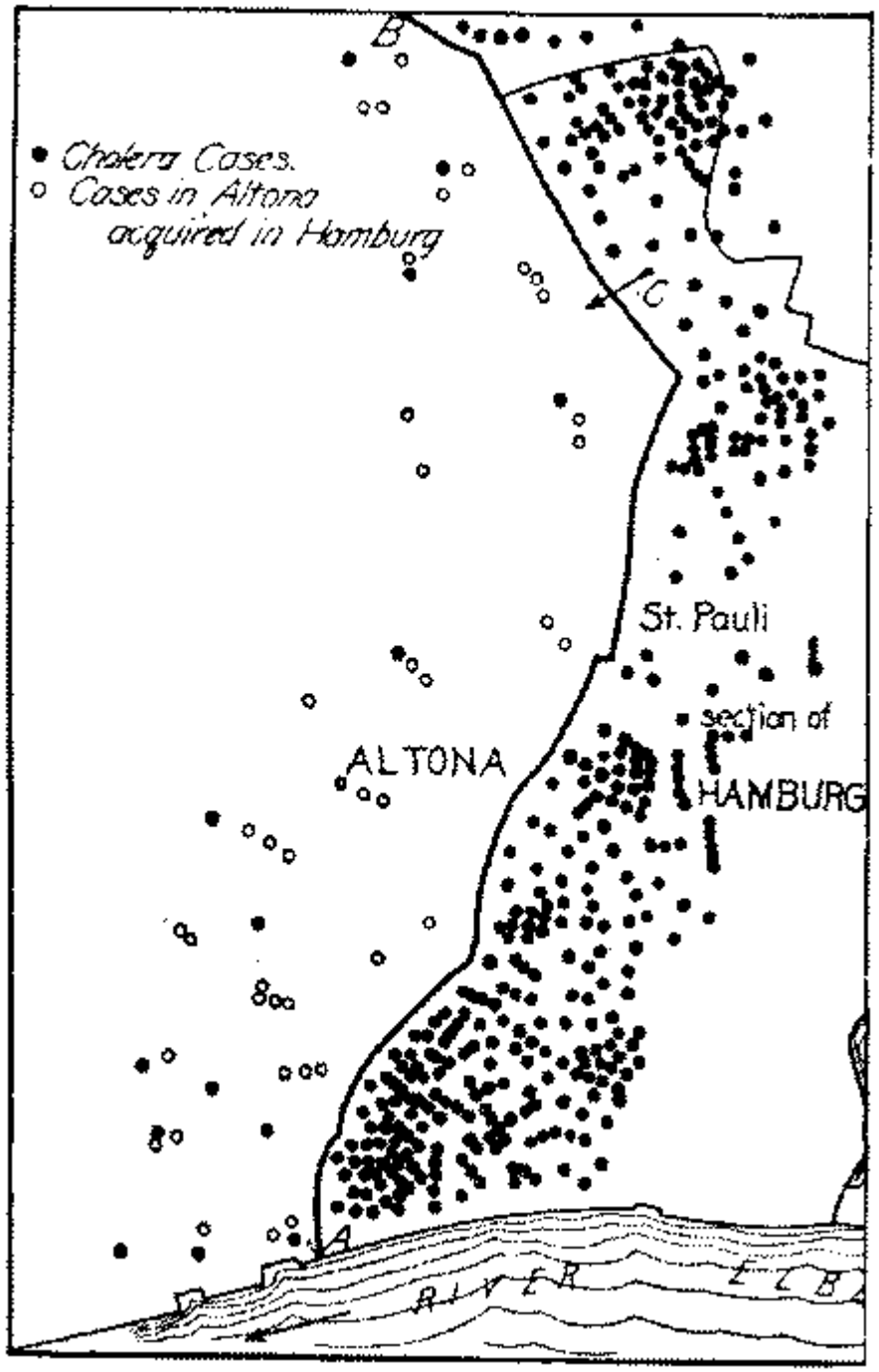
The Chelsea filter was continued in use until 1856, when the company began filtering water from an intake at Surbiton, higher up the Thames.

1832 : The great common sewers discharged into the Thames river. This was the Source of the Southwark Water Works.

Monster Soup

commonly called Thames Water. A magnified drop of water is shown to contain grotesque aquatic creatures in this satire on the Metropolitan Water supply Commission, which reported in 1828.

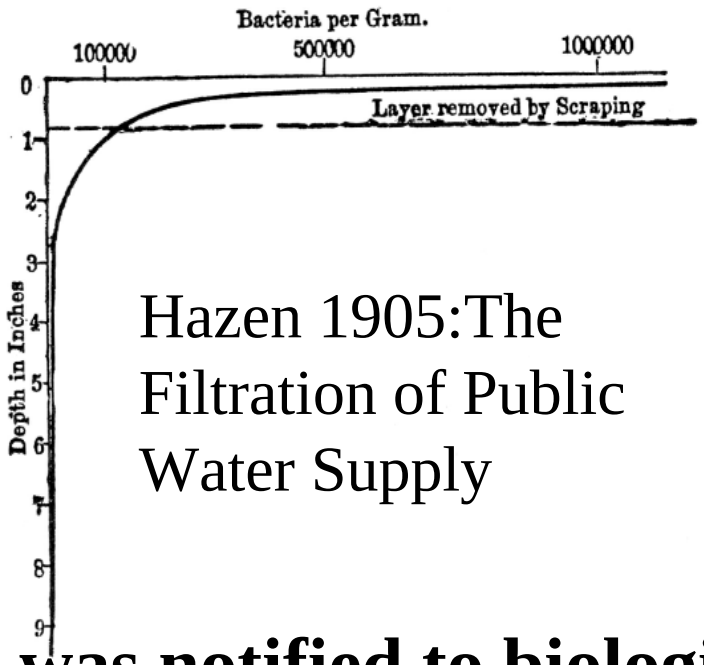




Death in Hamburg:

One of the most cited examples of waterborne disease was the cholera epidemic in Hamburg, Germany, in **1892**, which received its water from the same location but filtered it before distribution (Humburg), escaped the cholera epidemic (Altona).

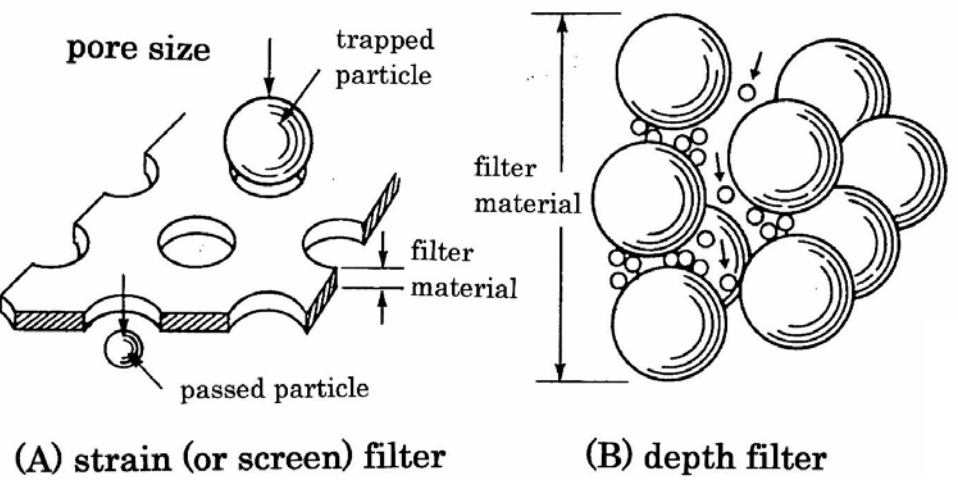
Baker 1949



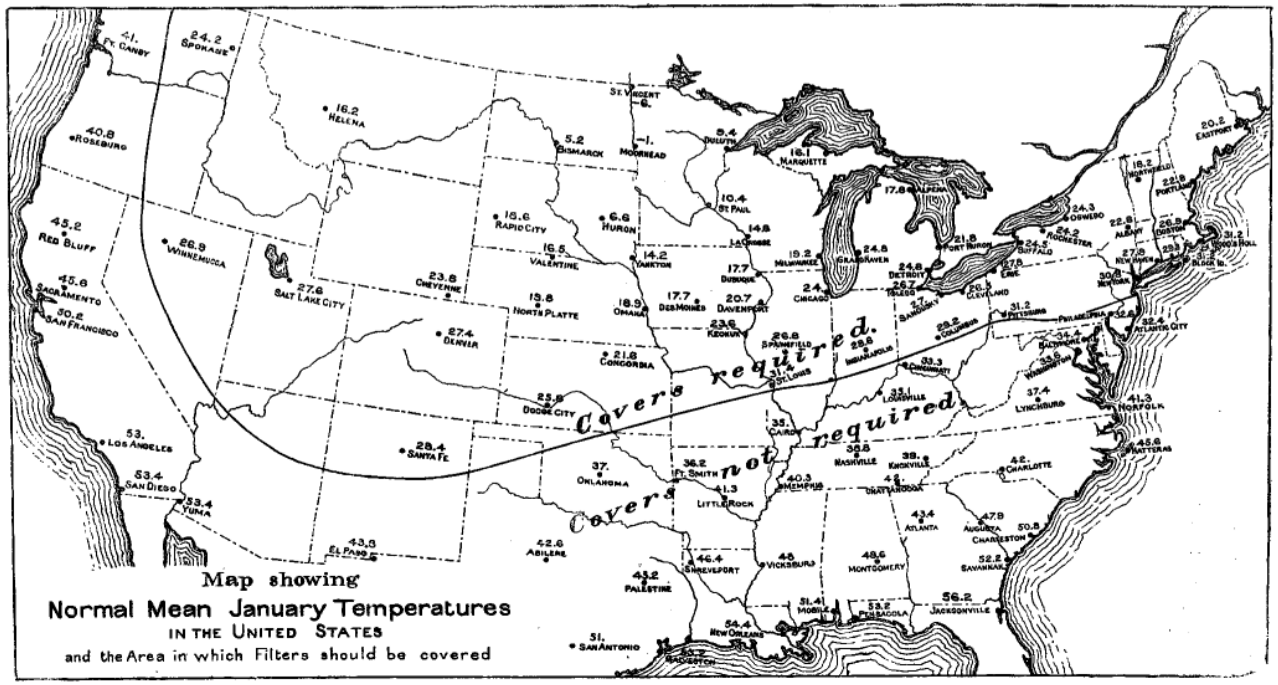
Hazen 1905:The Filtration of Public Water Supply

Report in 1893(Berlin):Bacteria and dirty matter were accumulated at the top of sand layer. Depth of scraping was deep in winter, shallow in summer. However, algae was in bloom. Reduction of bacteria in open filters is effective and more clear filtrate water in comparison with open and covered filters during 20 years. It may be especial case.

It was notified to biological phenomenon. However, he said that physical process was main.

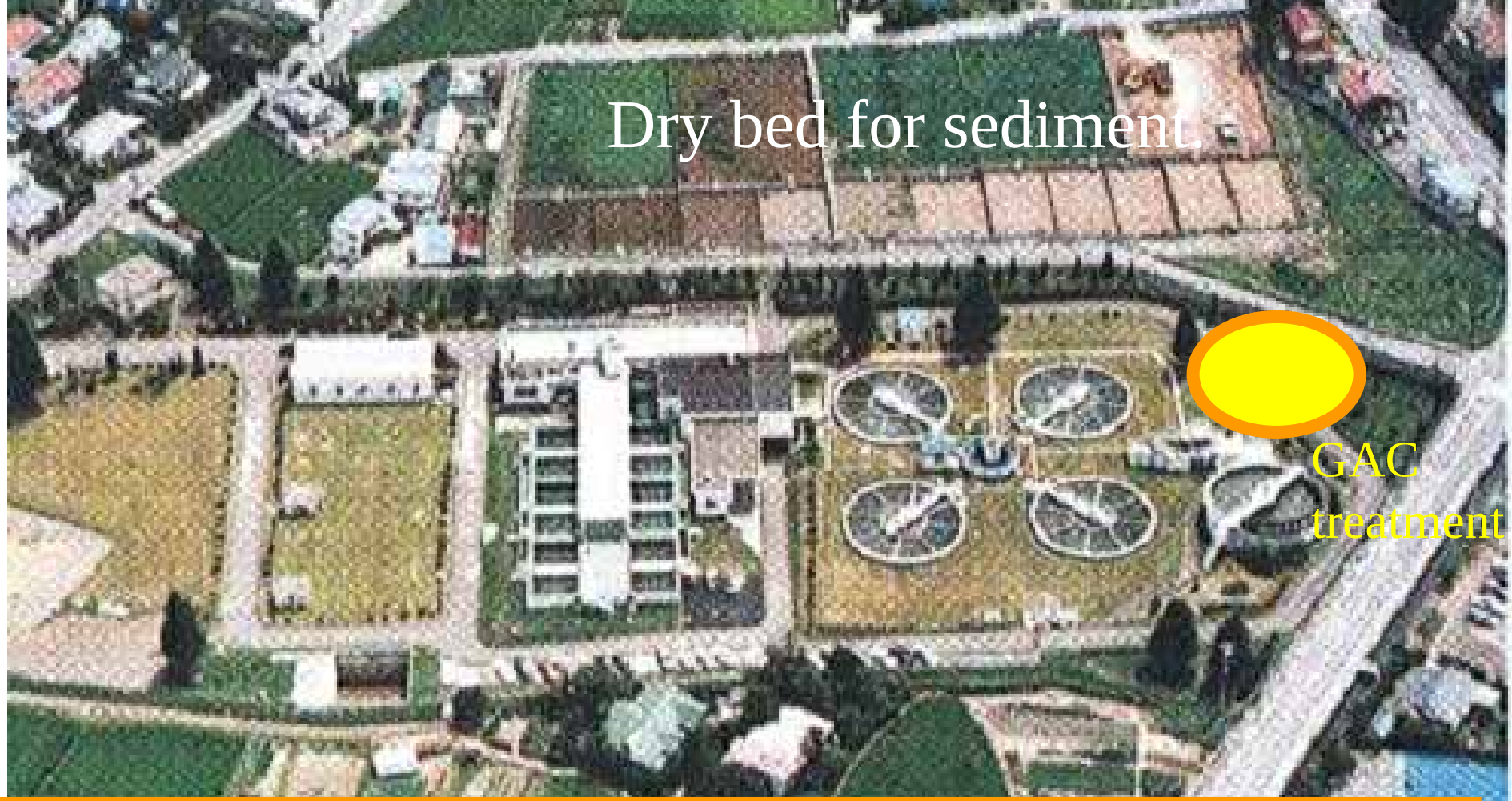


Removal of pathogens is not explained by these phenomena in comparison with size of microbial pathogens and opening space of sand grains. We can not explain the reduction mechanism of pathogens by physical phenomena.



It was costly to remove the ice on a filter. He recommend the covered filter in cold region.

Covered filter:
Iizuna waterworks,
Nagano



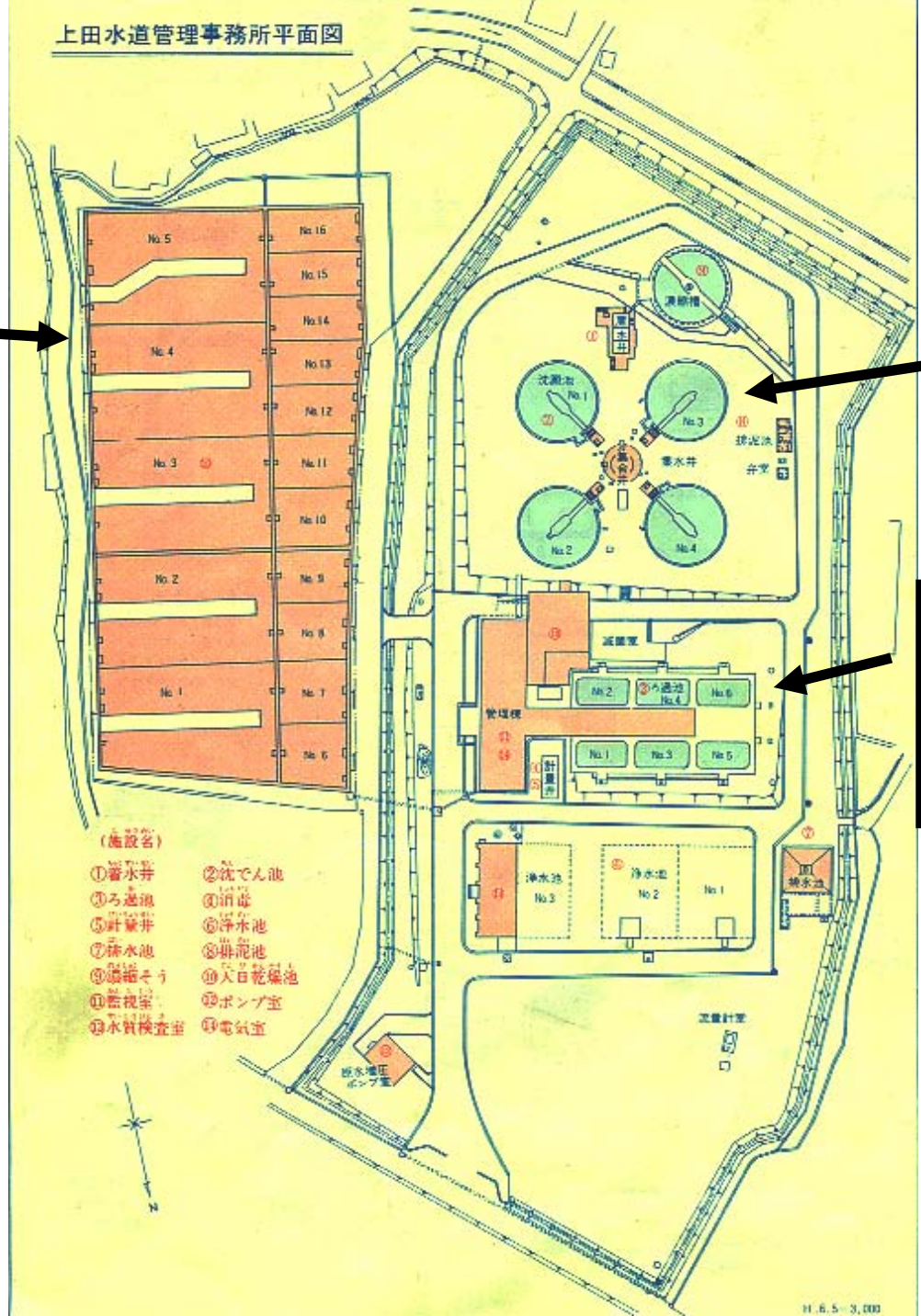
High efficiency of Rapid sand filter system is only for rapid sand filter. True efficiency is not so effective for total system. Chemical treatment produces cancer risk material, and other risks of an odor problem, cryptosporidium and etc. It produces so much waster material by chemical treatment. This system is not so easy maintenance for local people. This system is required special professional person.

Modern system of rapid sand filter is uncompleted and faulty system.

Rapid sand filter system: Ueda

Drying bed for waste sediments.

Other space except rapid sand filter is large.



Mixing and sedementetion basin

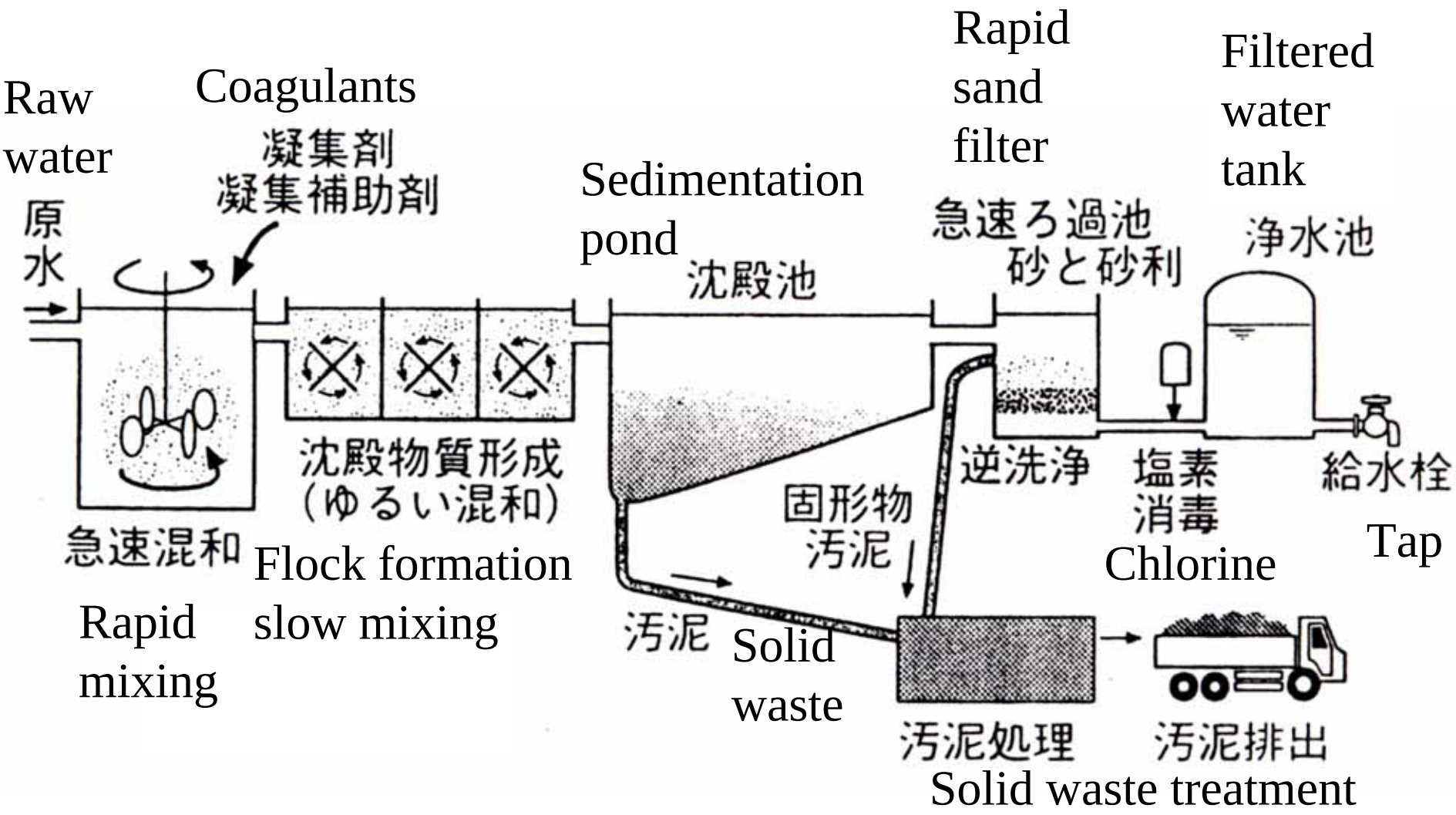
Rapid sand filter

Kanamachi waterworks, Tokyo :Industrial waterworks : chemical and machine

Rapid sand filtration: Ozone, Activated Carbon, …

American commercial filter

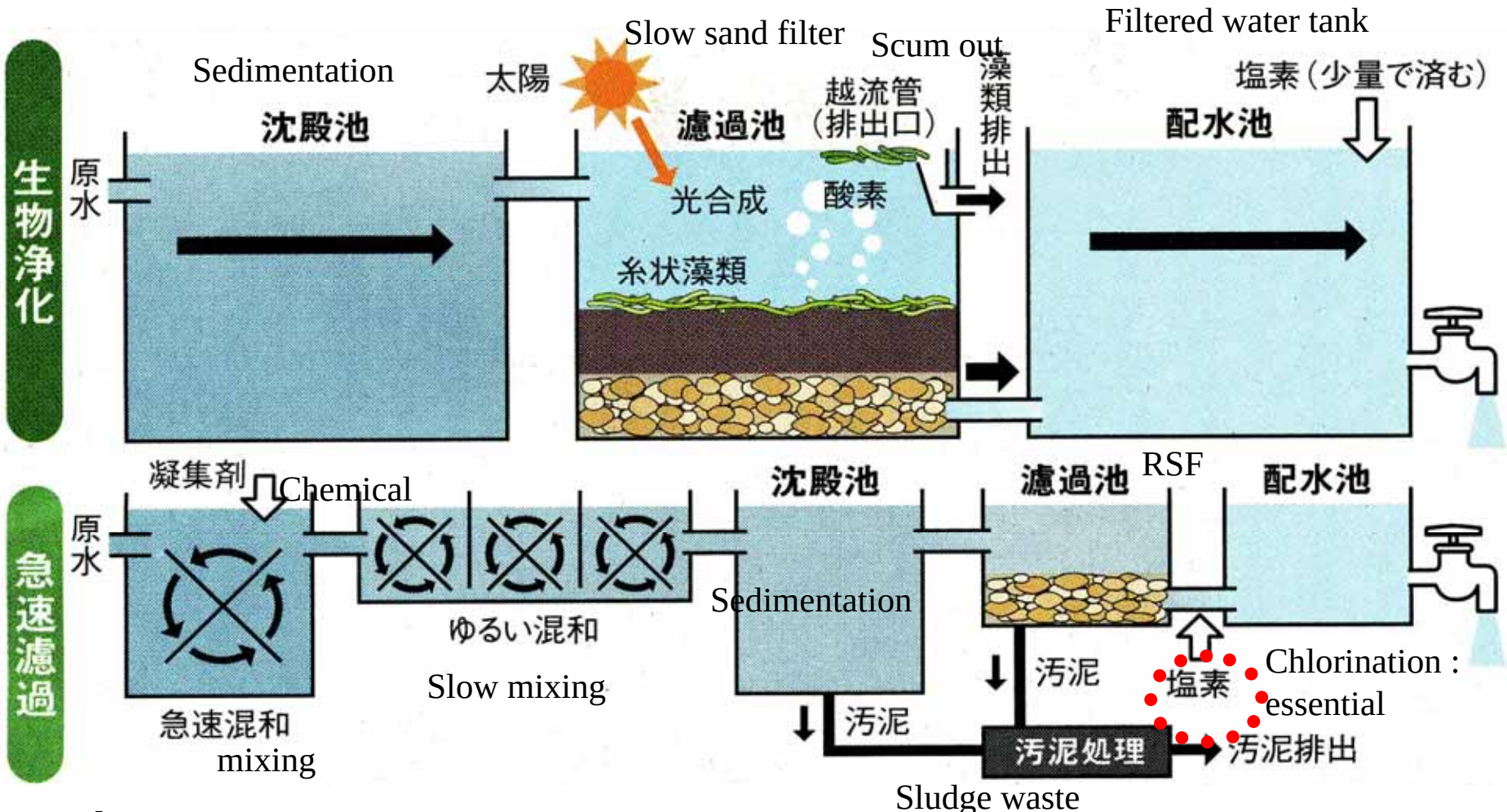
Outline of Rapid sand filter system



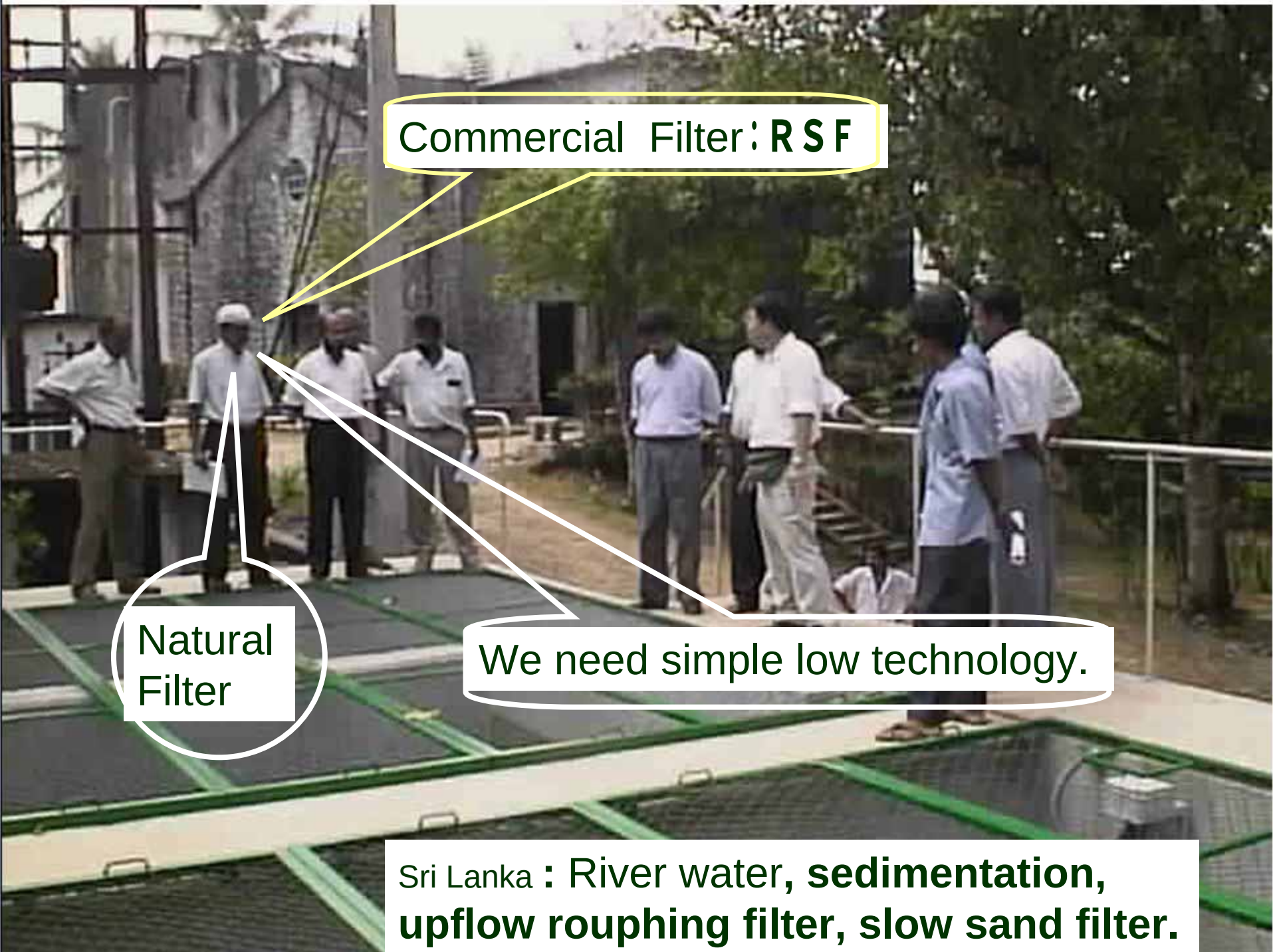
Bacteria removal is insufficient.→Disinfection by chlorine is necessary.

Ratio of fecal coli form bacteria in coli form bacteria is only about 1%. Fecal coli form bacteria are essential bacteria in the intestine and are not pathogenic bacteria. It is an indicator of pathogenic bacteria through the human intestine.

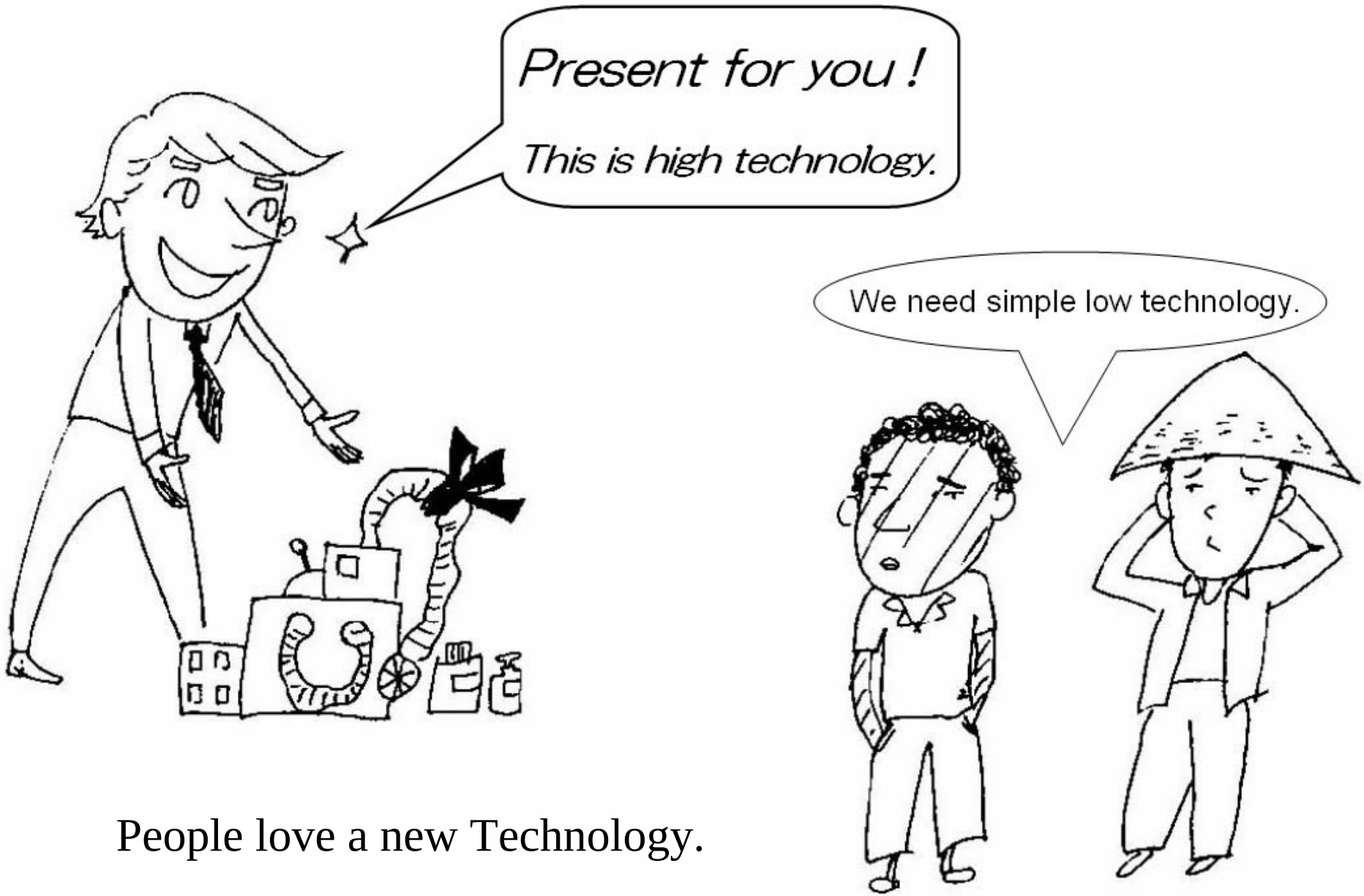
Slow sand filtration: Ecological purification system



Rapid sand filtration: Chemical purification system



Sri Lanka：River water, **sedimentation, upflow rouphing filter, slow sand filter.**

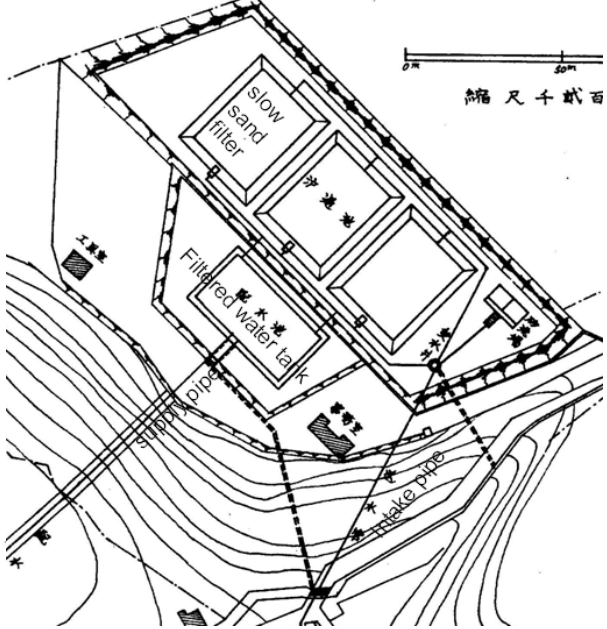


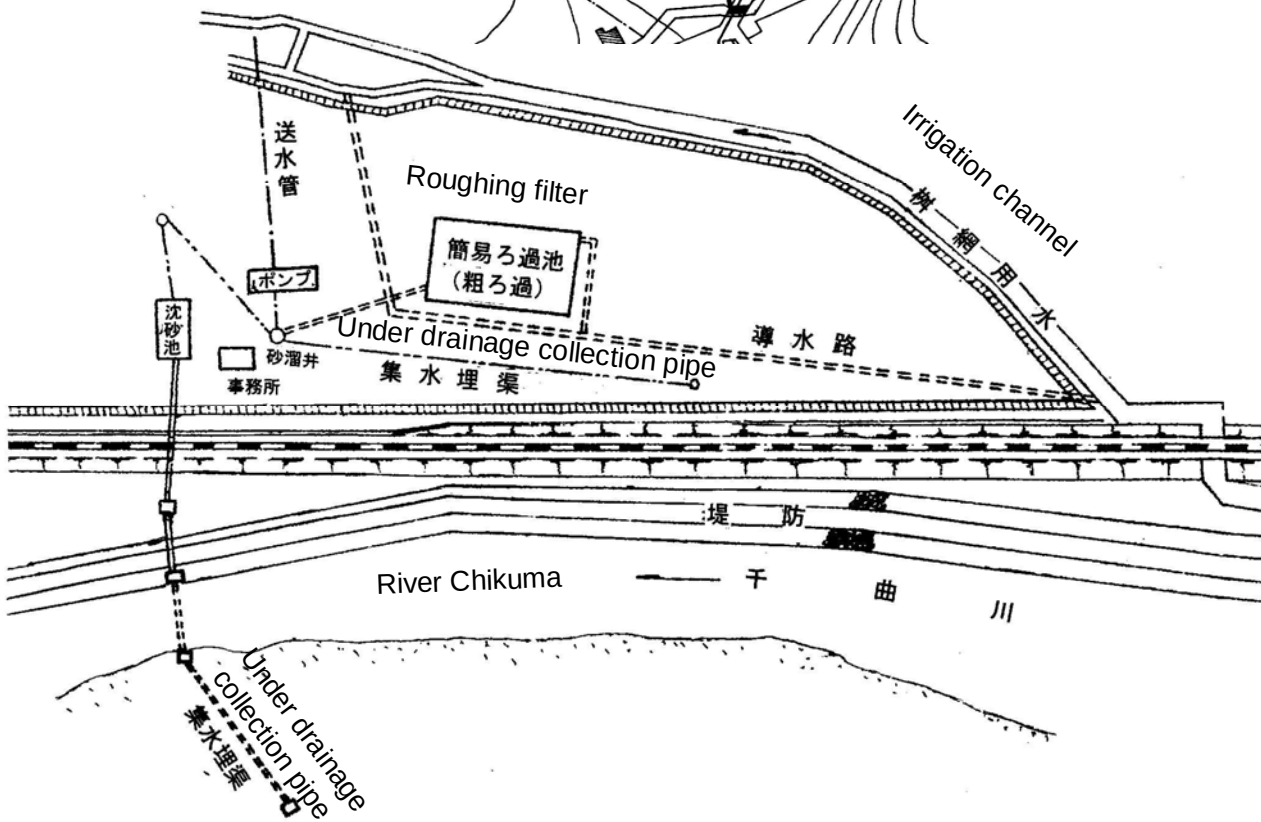
People love a new Technology.

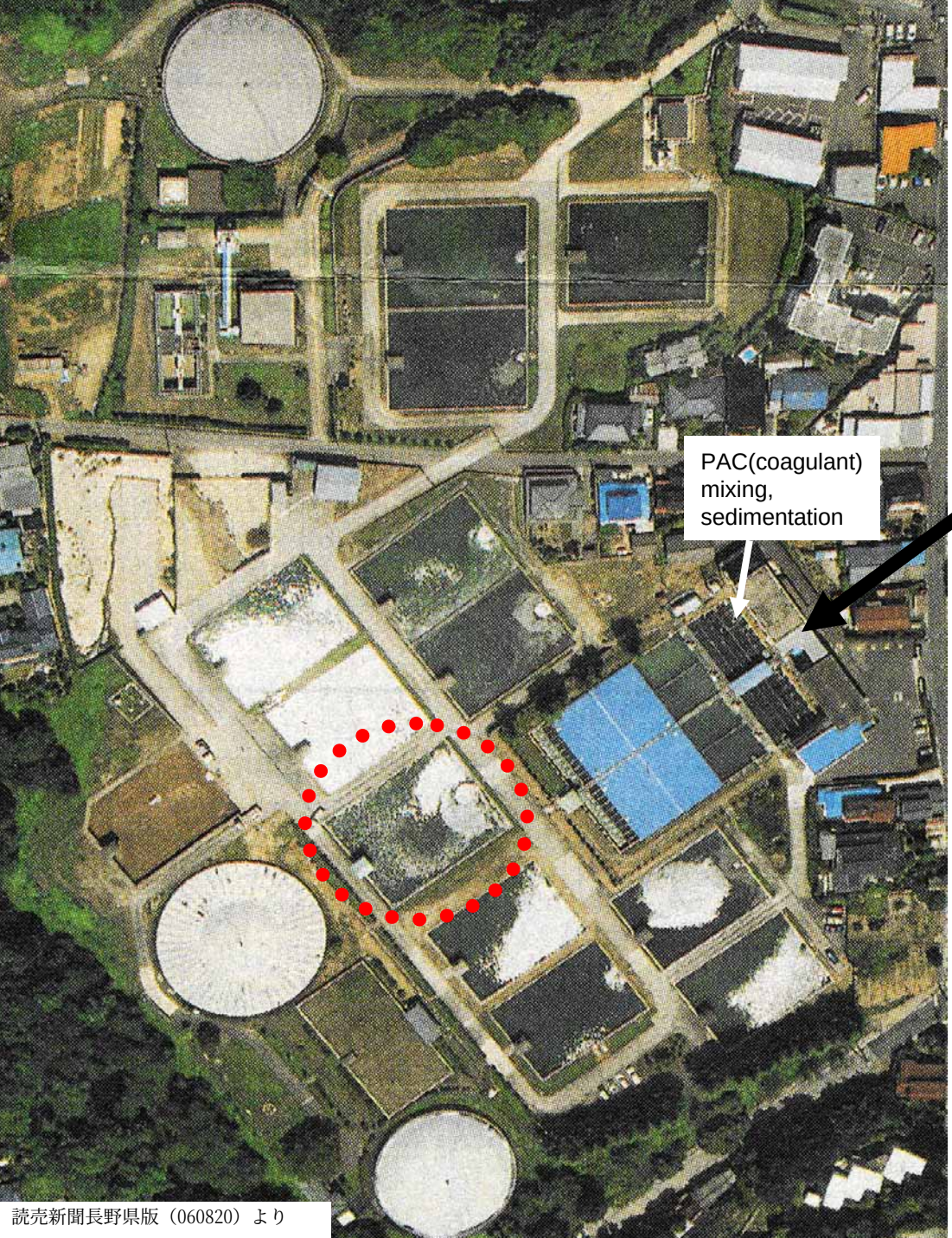
We expect new world.

Someya waterworks, Ueda city, Nagano was completed in 1923.
Subsurface underground water of River Chikuma was taken and was pumped up to the filter plant.

Original waterworks has 3 filters and storage tank.







読売新聞長野県版（060820）より

In 1964, Sugadaira reservoir was completed at about 15 km up from the waterworks. This water flows to Kangawa river and flows to the waterworks.

Present waterworks has 13 filters. Only one original slow sand filter pond is remained. The side wall of the original filter pond is slant wall like a natural pond. In case of other new filter pond, the wall are all vertical wall.

In case of the old filter, algae grows well and easily grow at the shallow place on a slant wall of the old filter. Seed of algae easily stop and hang on the slant wall.

Area of each one filter bed is 780m2. Total area of filtering space is 10,140m2 (＝ 780m2 **x** 13). If 13 filters are operated under normal Japanese standard filtering rate (4.8m/d), total capacity of filtered water is 48,672m3 (＝ 10,140m2x4.8m).

The capacity of water demand is 162,240 persons (0.3m3/d/person).


3 11:03

Floating algal scum is observed under sunshine on a slow sand filter at Someya Water works at Ueda city. One filter pond:780m2 (19.5mx40m) x 5m/d = 3,900m3/d 0.3m3/d/person = 13,000 persons