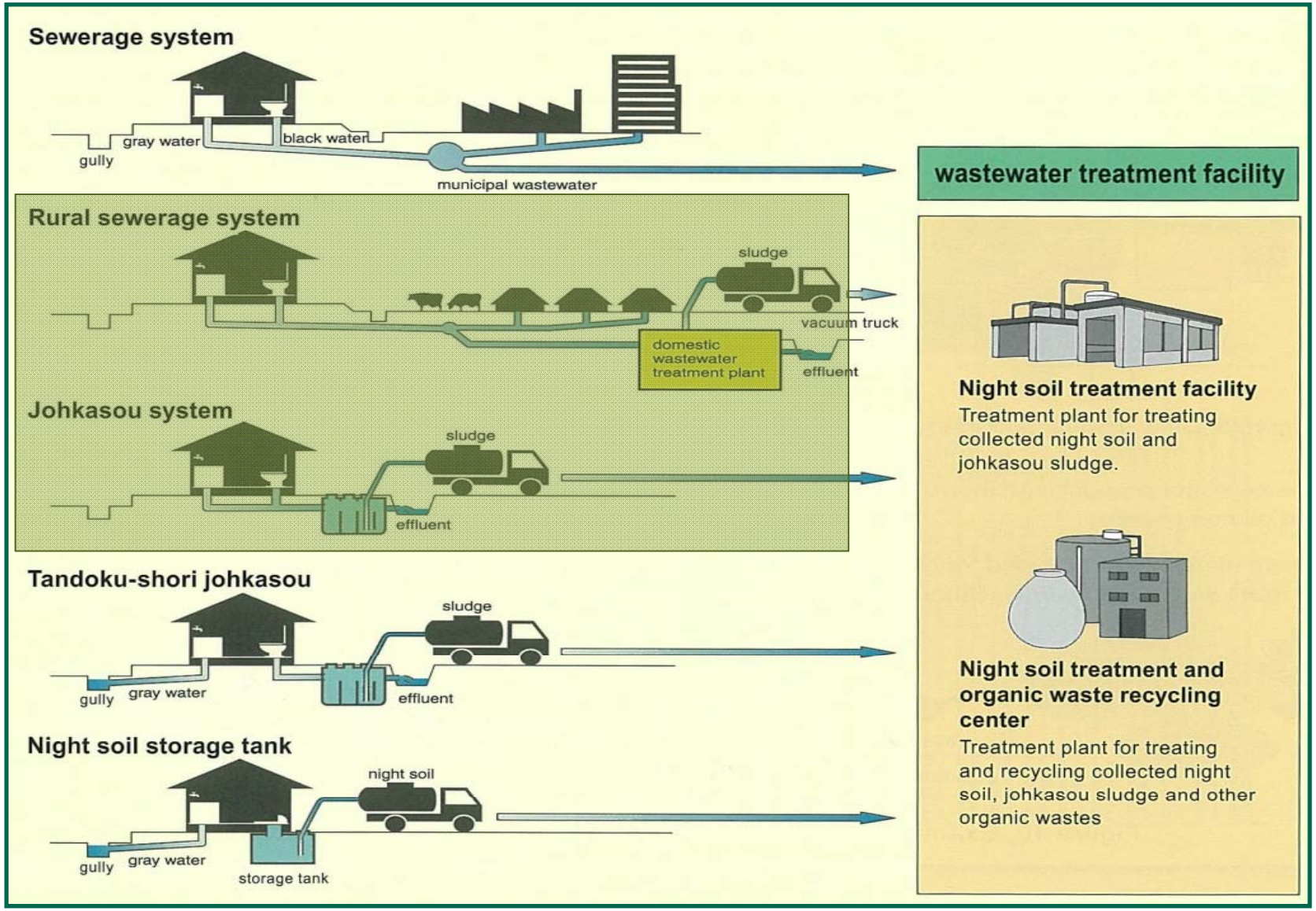
Japan's Experience in Decentralized Sanitation (Johkasou)

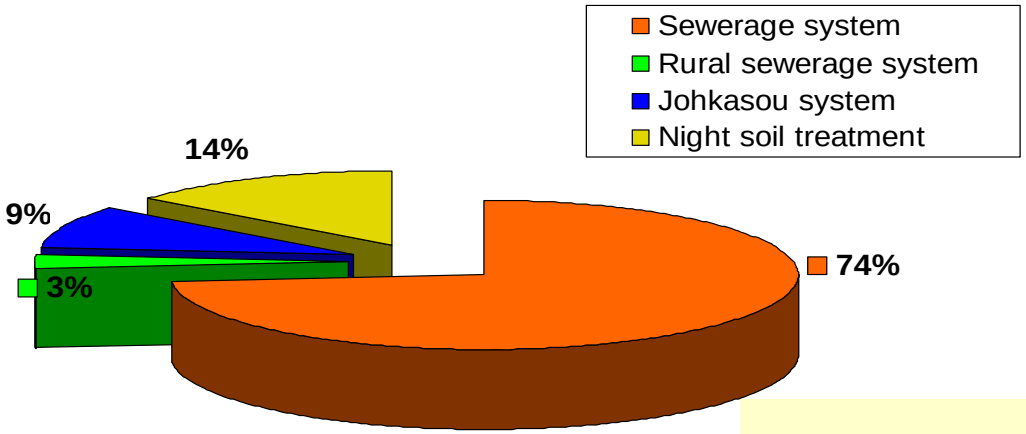
Xinbi Yang
Japan Education Center of Environmental Sanitation

Aizawl, INDIA
28 Feb. 2012

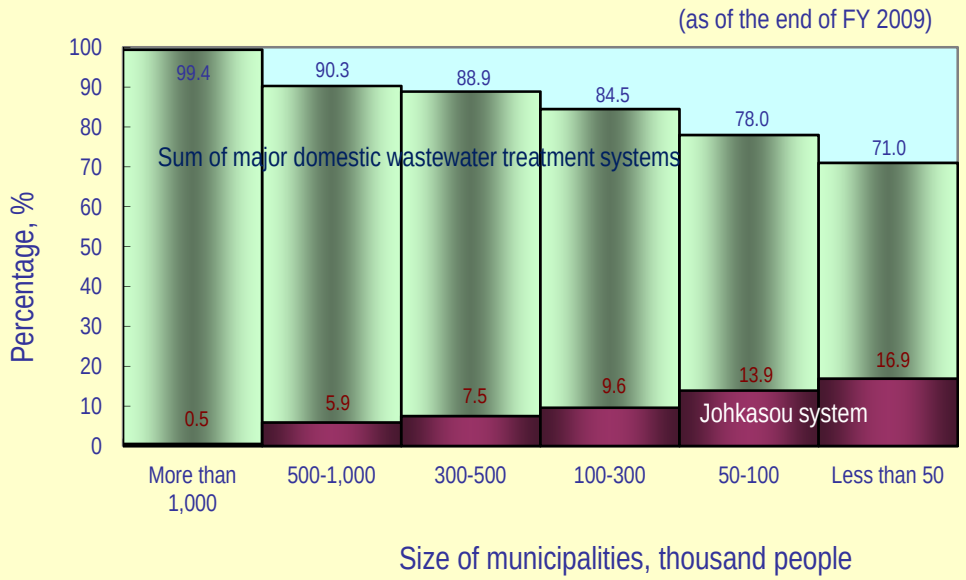
Night Soil and Domestic Wastewater Treatment Systems in Japan



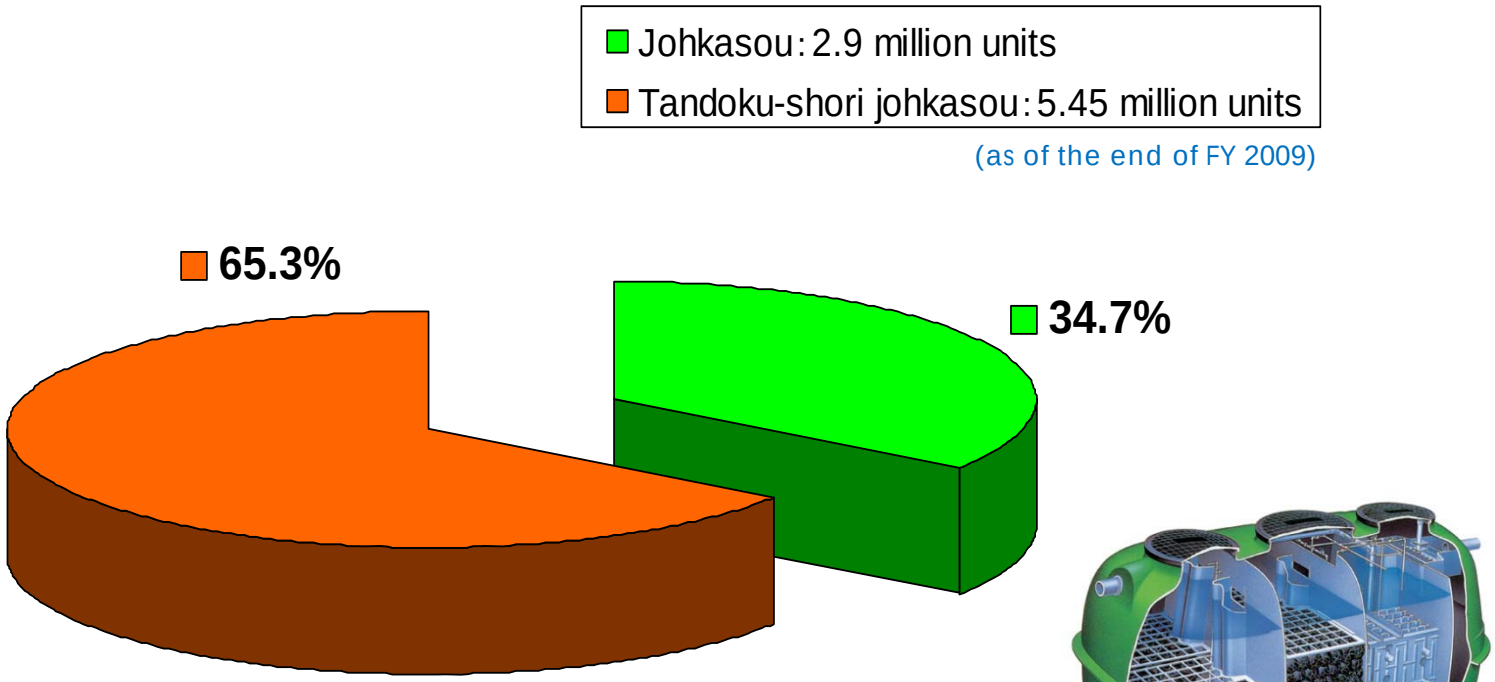
Population Served by Different Systems



(as of the end of FY 2009)



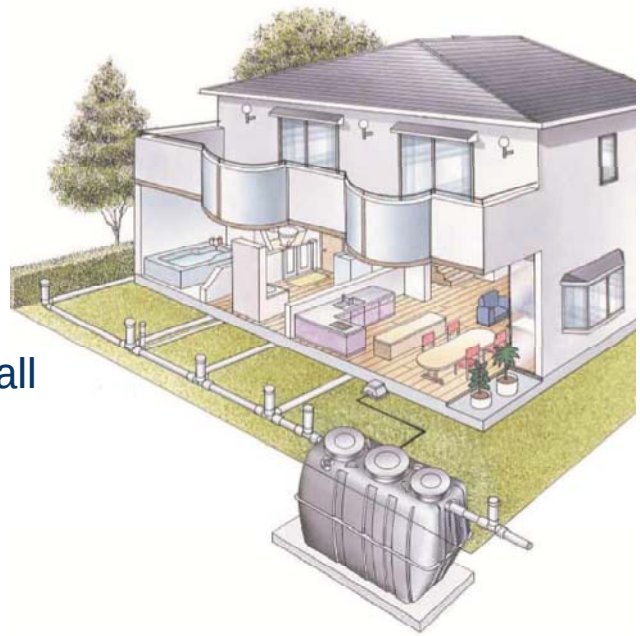
Number of Installed Johkasou



A small-scale johkasou

Advantages of Johkasou System for Decentralized Treatment

- Low initial investment cost
- Little topographic limitation, short installation time and early realization of the effects
- Invaluable contribution to maintaining sufficient water in small rivers and aquatic environments near inhabited areas
- Johkasou-treated water and sludge are easy to reuse
- Less vulnerable to earthquakes and other disasters



Pollutant Loads for Johkasou Design

Source of wastewater		Wastewater amount [l/cap.·day]	BOD · Load [g/cap.·day]	T-N · Load [g/cap.·day]	T-P · Load [g/cap.·day]
Flush toilet wastewater	Flushing	50	13		
Miscellaneous domestic wastewater	Cooking	30	18		
	Washing	40	9		
	Bathing	50			
	Washing face/hands	20			
	Cleaning	10			
Total		200	40	10	1.0

Determination of Johkasou Size in Buildings Classified by Purpose of Use (Examples)

JIS A 3302 *2000*

Classification number	Purpose of building use		Number of users for designing	
			Calculation formula	Remarks
2	Housing and related facilities	Residence	n = 5 $A \leqq 130\ m^2$ n = 7 $A > 130\ m^2$	n = number of users for designing A = total floor area (m^2)
		Lodging house and dormitory	n = 0.07A	n = number of users for designing A = total floor area (m^2)
		School dormitory, Self Defense Force camp, old-age home, and protective institution	n = P	n = number of users for designing P = capacity

Structure and Treatment Performance of Johkasou

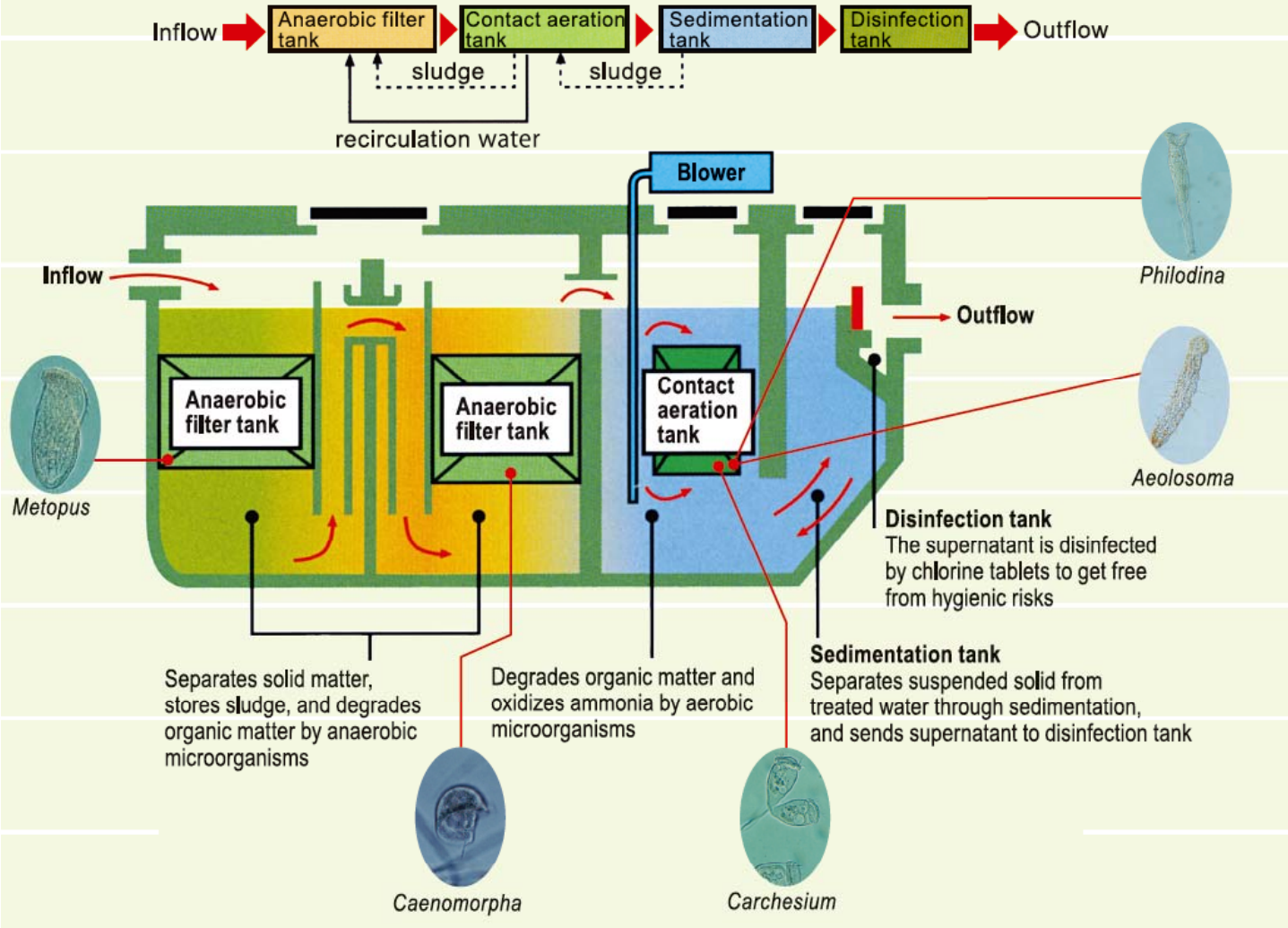
Table 5 Outline of Structural Standards for Johkasou

Class	Type of treatment	Treatment process	Number of users for design (5 50 100 200 500 2000 5000)	BOD removal rate	Treatment performance: Effluent quality (mg/ℓ) BOD	COD	T-N	T-P
1	Combined domestic wastewater treatment	Separation-contact aeration process		90% or more	20 or less	—	—	—
		Anaerobic filter-contact aeration process					—	—
		Denitrification type anaerobic filter-contact aeration process					20 or less	—
4	Flush toilet wastewater treatment	Septic tank process		55% or more	120 or less	—	—	—
5		Land infiltration process		SS: 55% or more	SS: 250 or less	—	—	—
6	Combined domestic wastewater treatment	Rotating biological contactor process		90% or more	20 or less	30 or less	—	—
		Contact aeration process						
		Trickling filter process						
		Extended aeration process						
		Conventional activated sludge process						
7		Contact aeration and trickling filter process		—	10 or less	15 or less	—	—
		Coagulation separation process						
8		Contact aeration and activated carbon absorption process		—	10 or less	10 or less	—	—
		Coagulation separation and activated carbon absorption process						
9		Nitrified water recirculation type activated sludge process		—	10 or less	15 or less	20 or less	1 or less
		Tertiary treatment type denitrification dephosphorization process						
10		Nitrified water recirculation type activated sludge process			10 or less	15 or less	15 or less	1 or less
		Tertiary treatment type denitrification dephosphorization process						
11		Nitrified water recirculation type activated sludge process			10 or less	15 or less	10 or less	
		Tertiary treatment type denitrification dephosphorization process						

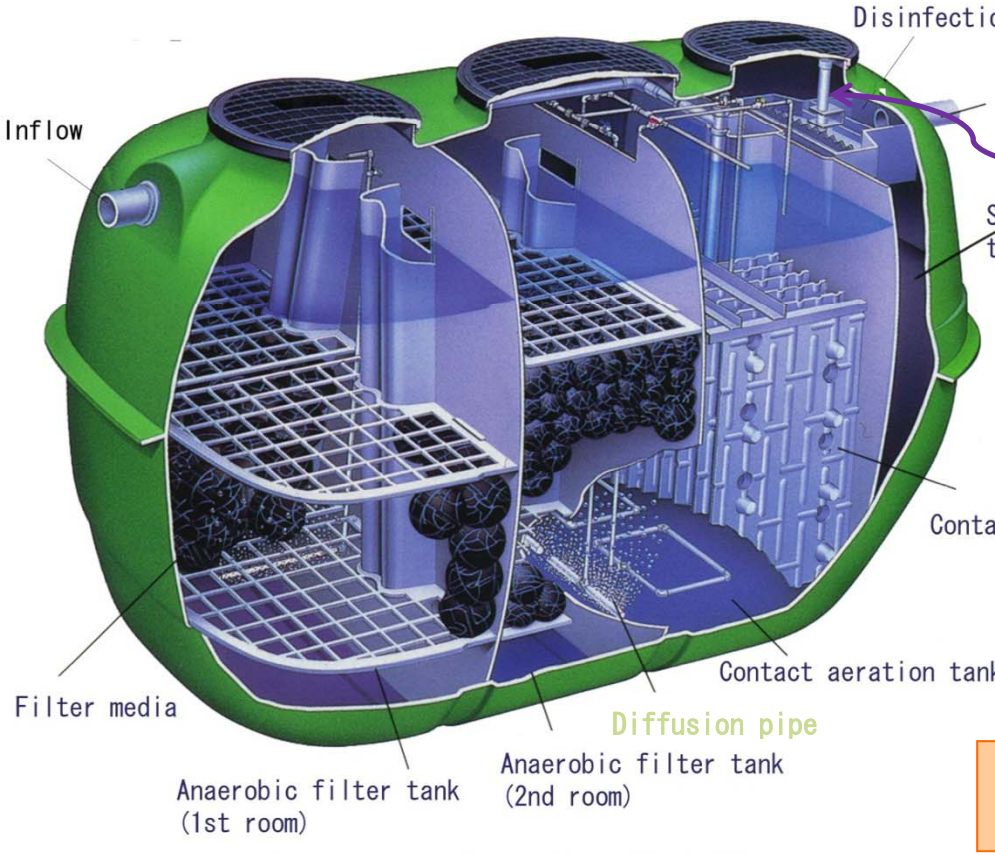
12 Emission standard under the Water Pollution Control Law	COD (mg/ℓ)	SS (mg/ℓ)	n-Hex (mg/ℓ)	pH	Total coliforms (N/mℓ)
Class: 6 - 11	60	70	20	5.8~8.6	3,000 or less
6 - 11	45	60	20	5.8~8.6	3,000 or less
6 - 11	30	50	20	5.8~8.6	3,000 or less
7 - 11	15	15	20	5.8~8.6	3,000 or less
8	10	15	20	5.8~8.6	3,000 or less

note: Class 2 and Class 3 were deleted in 2006.

Treatment Principles of Johkasou

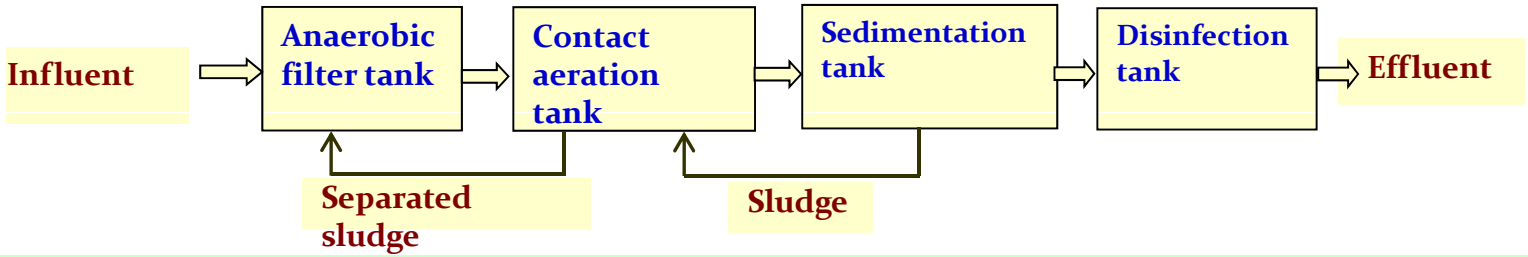


A small-scale Johkasou (FRP)

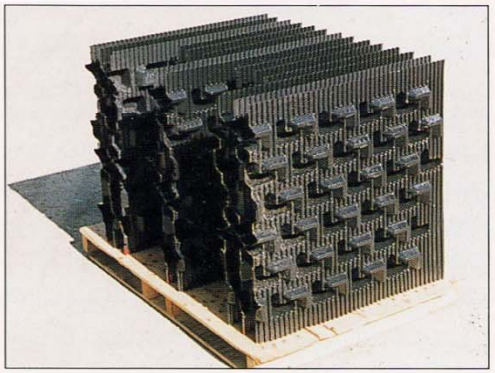


Effluent water quality
BOD <=20 mg/l

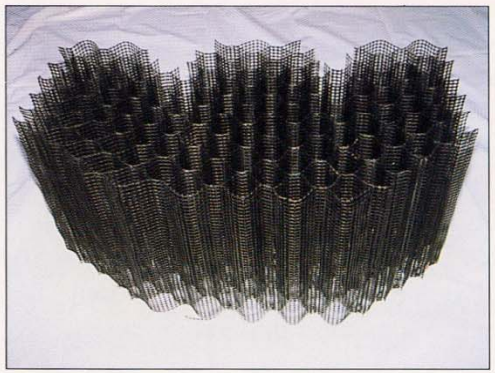
An example of small-scale johkasous



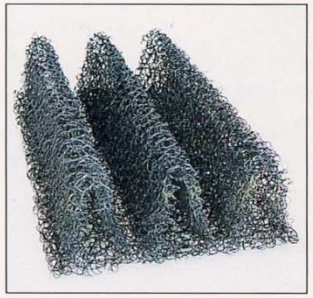
Filter Media Used in Johkasou



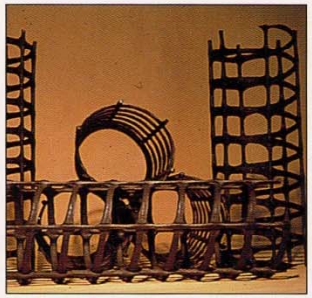
1. Plate



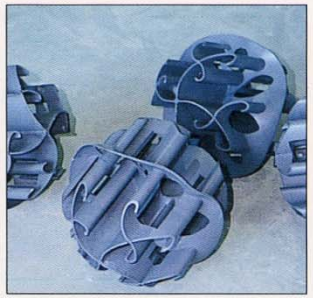
2. Netlike plate



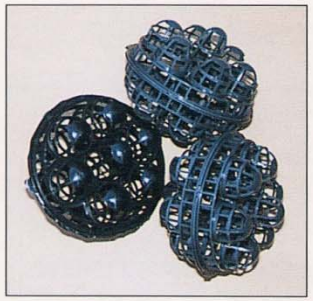
3. Loofahlike shape



4. Netlike - cylinder

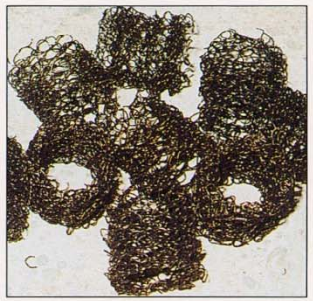


5. Balllike shape



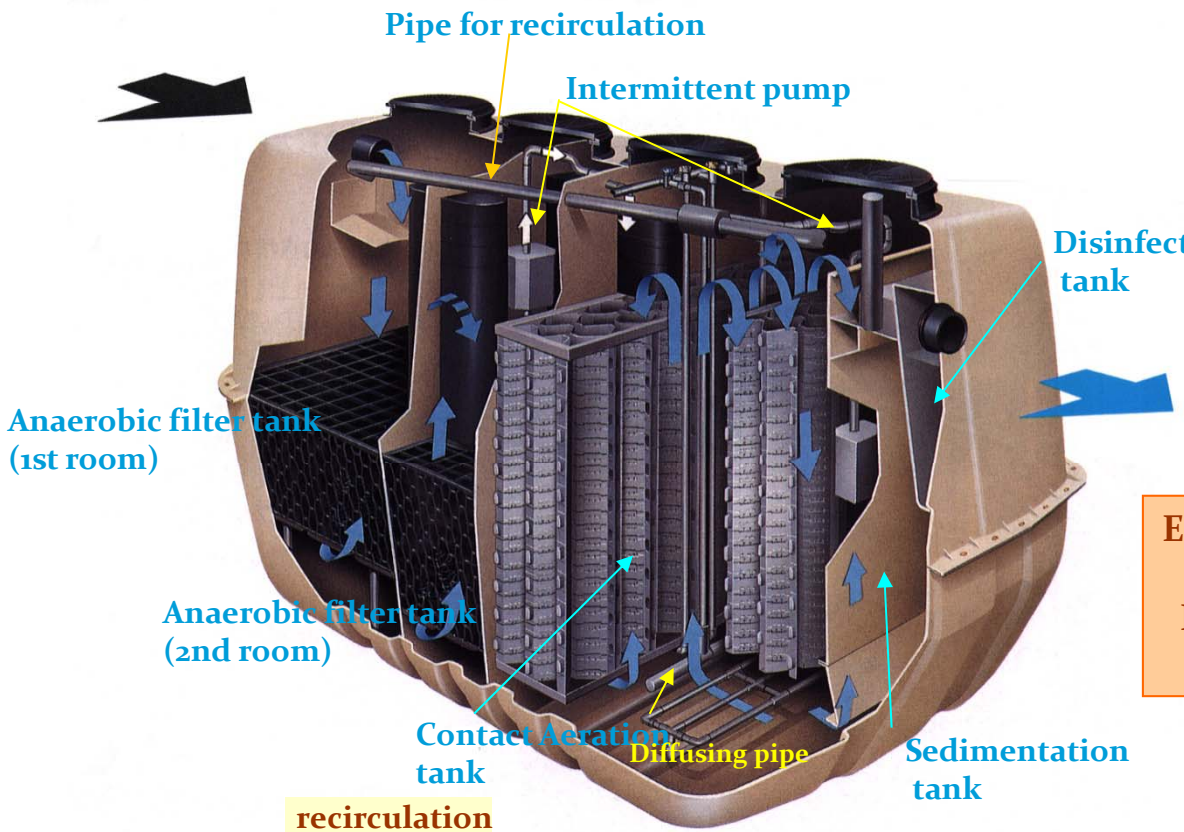
6. Balllike shape

7. Braids



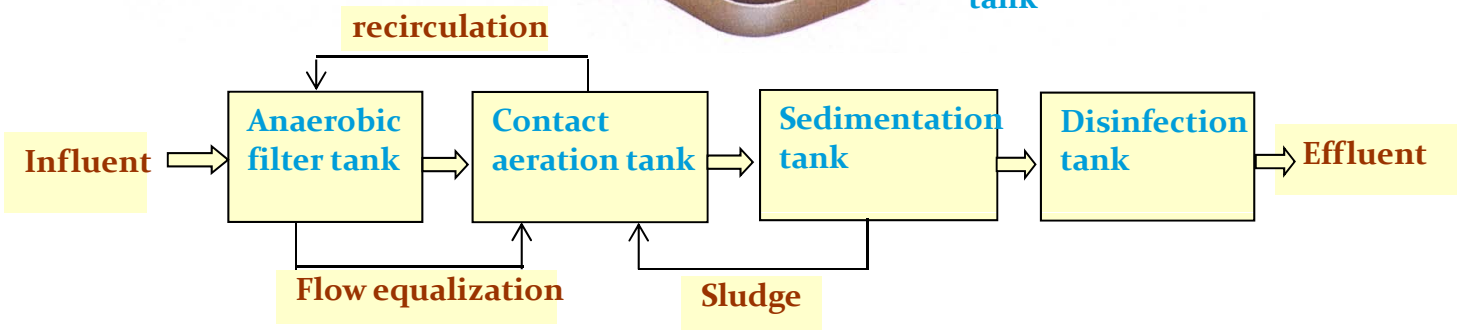
8. Loofahlike-cylinder

A Johkasou for BOD&N Removal

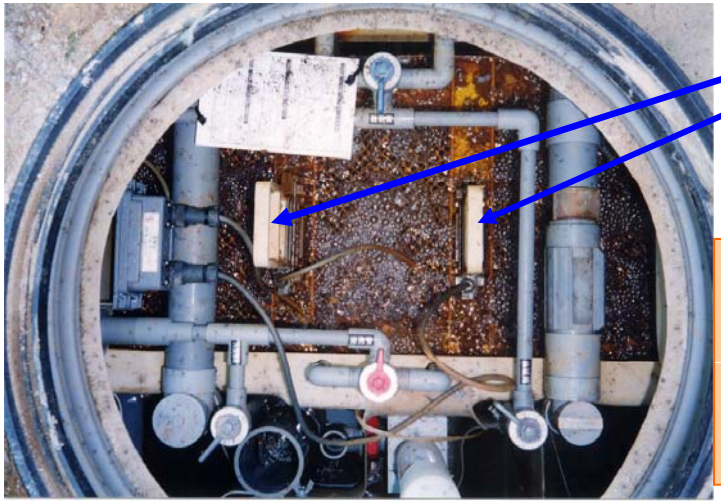


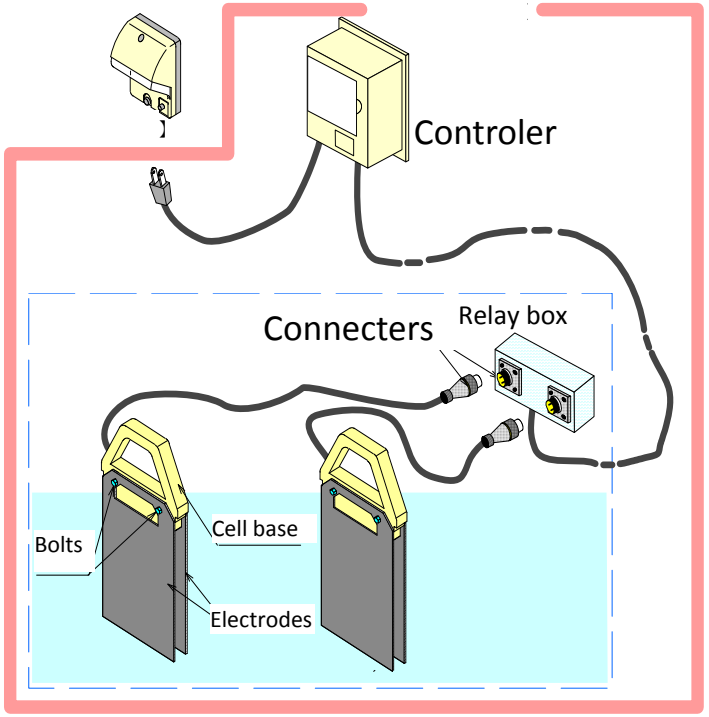
Effluent water quality

BOD <=20 mg/l
T-N <=20 mg/l



A Johkasou for BOD&N&P Removal

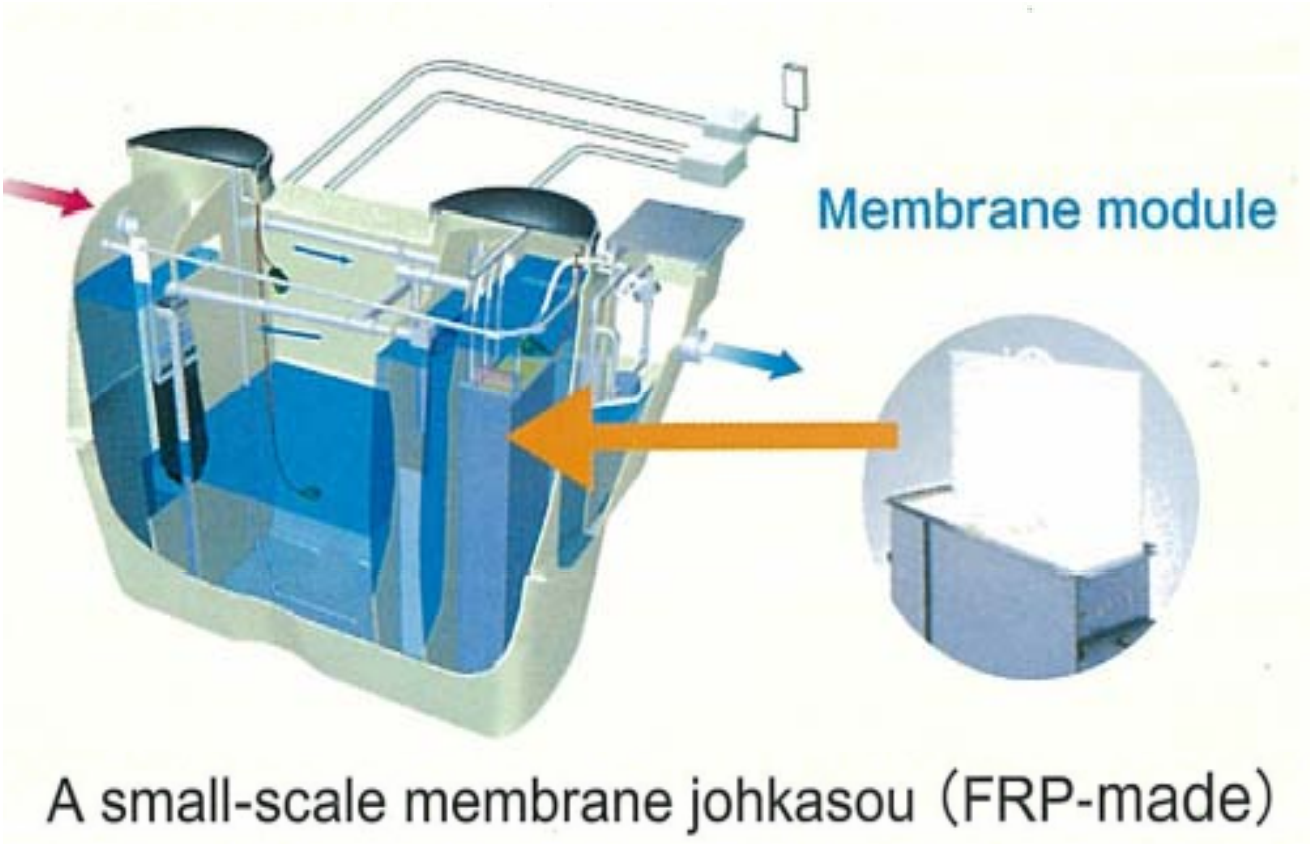




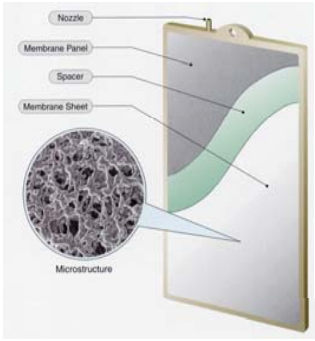
Effluent water quality

BOD <=10 mg/l
T-N <=10 mg/l
T-P <= 1 mg/l

A Membrane Johkasou



A small-scale membrane johkasou (FRP-made)



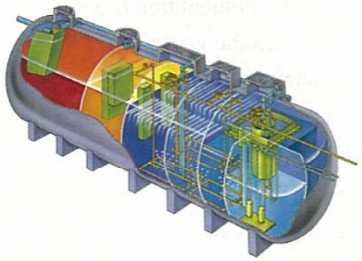
Effluent water quality
BOD <= 5 mg/l
T-N <=10 mg/l

Johkasou classified by the treatment capacity

- **Small-scale johkasou: for 5 to 50 NUD , or the average amount of wastewater less than 10 m^3/day.**
- **Medium-scale johkasou: for 51 to 500 NUD, or the average amount of wastewater less than 100 m^3/day.**
- **Large-scale johkasou: for 501 NUD or more, or the average amount of wastewater more than 100 m^3/day.**

NUD: number of user for design

Small-scale johkasou (FRP-made)



Medium-scale johkasou (FRP-made)

Large-scale johkasou (RC-made)

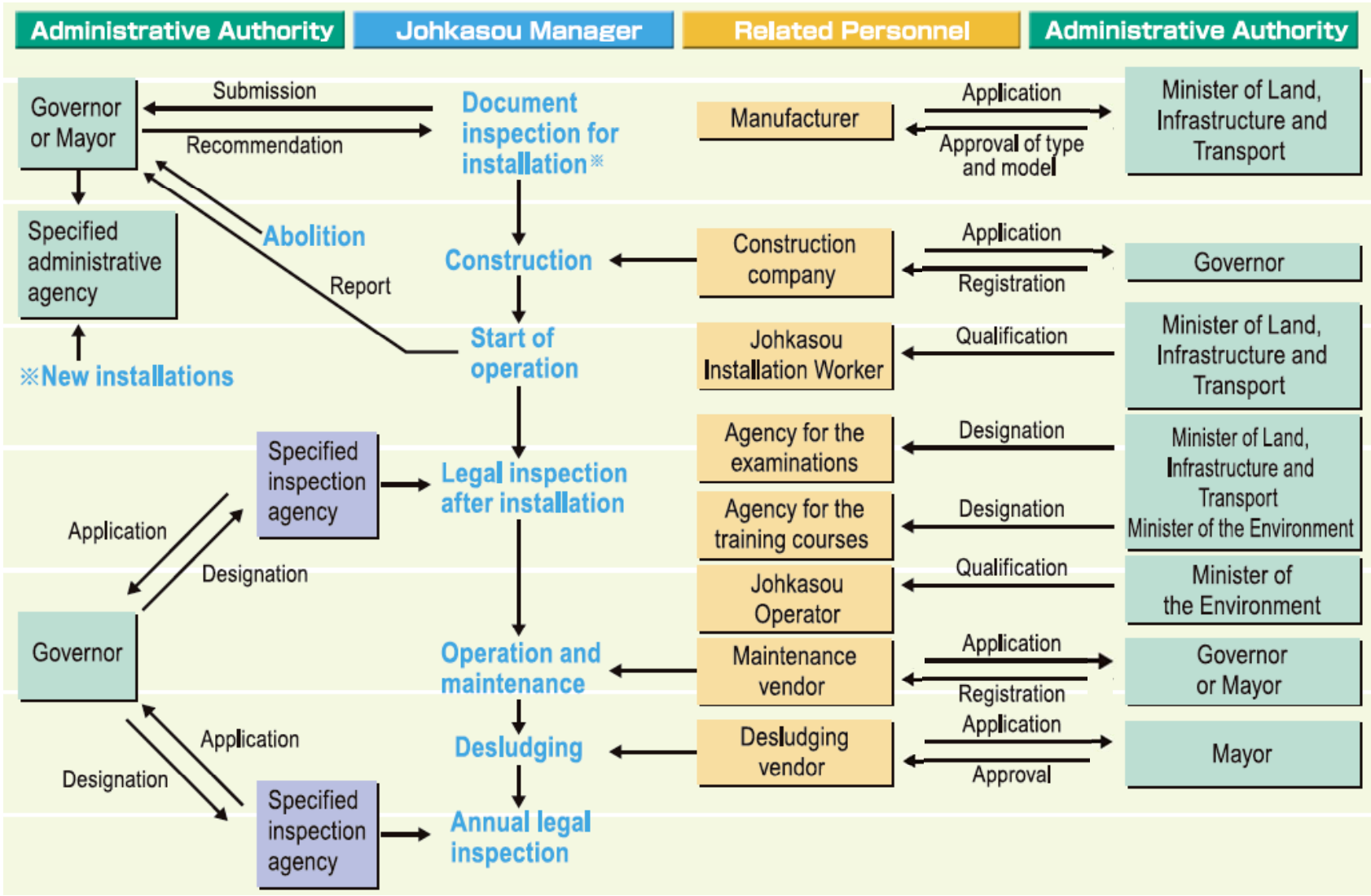
Installation, O&M and Desludging of Johkasou system

Installation

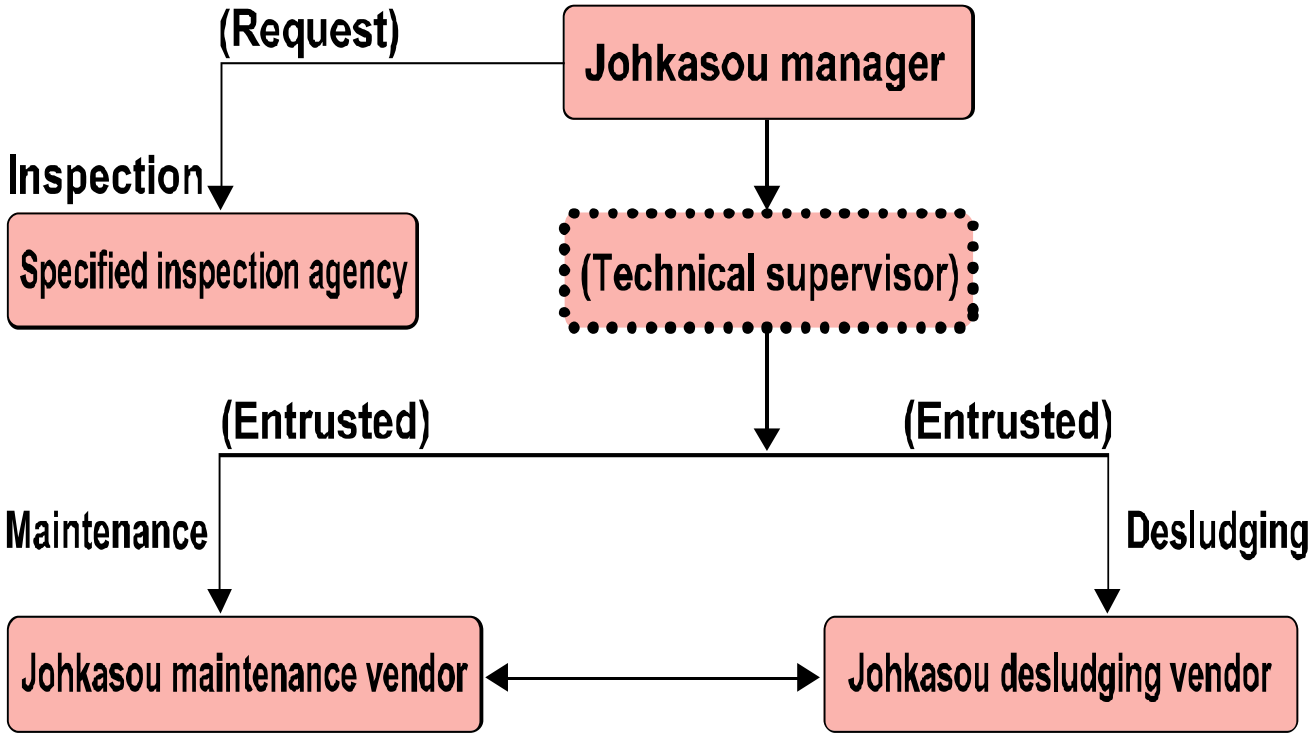
Operation＆Maintenance

Desludging

Legislative Infrastructure Underpinning Johkasou Systems



Operation, Maintenance and Inspection of Johkasou



Framework of johkasou management under the Johkasou Law

Construction of Johkasou

Earth excavation

●Earth excavation
Excavate a hole of the necessary size to install the johkasou.
Shoring may be required depending on the characteristics of soil or subsoil at the installation site. Excavation on sites with high ground water levels requires dewatering.

Foundation work

●Foundation work
Lay down a layer of rubble that is sufficiently compacted to keep the johkasou main unit horizontal and prevent the ground from sinking or rising. After pouring leveling concrete, pour the base-plate reinforced concrete to facilitate the horizontal installation of the johkasou and to transmit the weight of it and the superstructure to the ground.

Installation

●Installation
Install the johkasou in assigned location, making sure that it is leveled.

Water filling & Bckfilling

●Water filling
Fill the johkasou with tap water to protect it against damage and deformation during backfilling, and then check for leveling and for water leaks.

●Backfilling
First, tamp down the lower half and compact the earth by pouring water. Then, tamp down the upper half in the same way and fill in the space with earth to the bottom level of the inflow and outflow pipes.

Connecting pipes

●Connecting pipes
After sufficiently compacting the piping pathway section, fill in with earth and connect the inflow and outflow pipes. Pay attention to the gradient of inflow and outflow pipes when installing them. Install the pipes and pit and backfill the earth.

●Floor slab concrete work
Pour concrete on top of the backfilled earth to facilitate maintenance/inspection work, prevent the penetration of rainwater, and keep the johkasou from rising. This work can also be done after backfilling or connecting pipes.

Installing equipment

●Installing auxiliary equipment
Install auxiliary equipment, such as blowers and pumps, in their designated positions. The blower and other equipment that may generate vibration or noise must be installed after preparing the appropriate foundations.

Electrical work

●Electrical work
Install a waterproof power supply specially designed for the johkasou unit, and be sure to ground it to the earth.

Test operation

●Test operation
After construction work is completed, check whether each unit involved in the johkasou and its auxiliary equipment operates properly. At the same time, also check to ensure the johkasou is leveled, that there are no water leaks and that the flow of water is normal.

Delivery

●Delivery
Deliver the johkasou to the johkasou users together with the necessary documents after confirming that it operates properly. The details of how to use the johkasou and the managing of maintenance/desludging should be explained to the johkasou users.


Earth excavation


Base-plate reinforced concrete


Installation (confirmation of inside facilities)


Water filling


Backfilling


Connecting pipes


Upper part of concrete slab construction

Details of Operation, Maintenance and Inspection of Johkasou

Johkasou Inspector

Legal inspection by Article 7

Purpose
Confirm if the construction/ installation and treatment performance are good.

Contents
- visual inspection
- water quality inspection
- document inspection

Timing of implementation
Three to eight months after starting operation

Responsible organization
Specified inspection agency, which is a public service corporation of the prefecture.

Johkasou Operator

Operation/Maintenance

Purpose
Maintain a normal treatment performance

Contents
- sludge accumulation
- water quality
- mechanical apparatus
- replenish disinfectant

Frequency
Over three times a year, depending on the size and the treatment process

Responsible organization
Johkasou maintenance vendor, who is licensed by the prefectural governor.

Johkasou Desludging Technician

Desludging

Purpose
Recover normal treatment performance normally

Contents
- removing sludge
- cleansing the johkasou
- confirming if there are faults or defects inside the johkasou

Frequency
Once a year

Responsible organization
Johkasou desludging vendor, who is registered by the mayor.

Johkasou Inspector

Legal inspection by Article 11

Purpose
Confirm if the maintenance and desludging is done appropriately, and if the treatment performance is good.

Contents
- visual inspection
- water quality inspection
- document inspection

Frequency
Once a year

Responsible organization
Specified inspection agency, which is a public service corporation of the prefecture.

Johkasou Technicians and Vendors

Column 6 Johkasou technicians and vendors

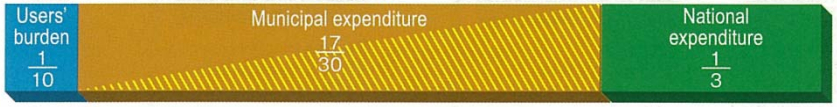
Qualifications/vendors	Registrant/ number of vendors	Business content	Legal Basis
Johkasou Operator	68,668	Operation and maintenance	Johkasou Law
Johkasou Installation Worker	81,464	Installation/construction	
Johkasou Technical Supervisor	25,105	Management of johkasou with 501 PE or more	Enforcement regulations of Johkasou Law
Johkasou Desludging Technician	14,782	Desludging	
Johkasou Inspector	1,119		
Specified inspection agency	66	Johkasou inspection and water quality examination	
Johkasou manufacturer	45	Research, development and manufacture	
Johkasou maintenance vendor	13,101	Operation and maintenance	Johkasou Law
Johkasou desludging vendor	5,573	Desludging	
Johkasou Installation vendor	35,388	Installation/construction	

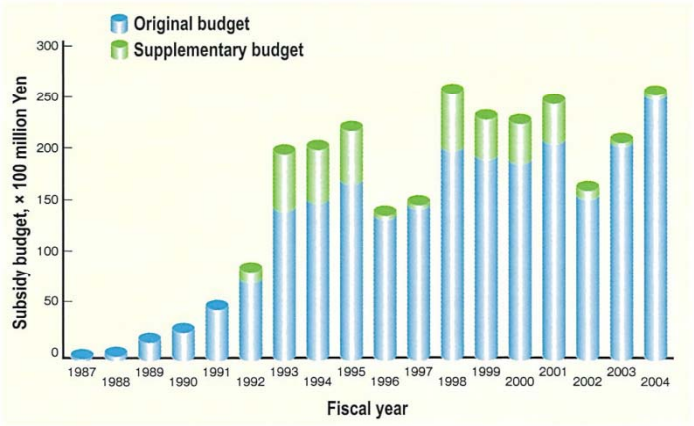
(As of the end of FY 2007)

Subsidy Programs for Johkasou Installation

• Johkasou Installation Promotion Program

• Municipal Johkasou Installation Program





For example, the cost of installing a johaksou for 5 PE is supposed to be 840 thousand Yen,
In the case of the Johkasou Installation Promotion Program, the user's burden is 504 thousand Yen, the government and municipalities pay 336 thousand Yen.
In the case of the Municipal Johkasou Installation Program, the user's burden is 84 thousand Yen, the government and municipalities pay 756 thousand Yen.

An example of maintenance cost of BOD removal type johkasou

	A johkasou for 5 PE	A johkasou for 7 PE
Annual cost	65,000 Yen	81,000 Yen
Items		
maintenance fee	21,000 Yen	22,000 Yen
desludging fee	26,000 Yen	35,000 Yen
electricity fee	13,000 Yen	19,000 Yen
inspection fee	5,000 Yen	5,000 Yen


株 新興WM工業

Summary

- Johkasou has economical advantages and is effective for decentralized sanitation in areas of low population density.
- Johkasou is a system including hardware (treatment plants) and software (O&M, inspection under a legal framework) . The latter issues is much more important in decentralized sanitation.
- The experience of Japan in decentralized sanitation with johkasou is useful and applicable to other countries as a prevalent measure of sanitation.