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Rapid Sand Filtration

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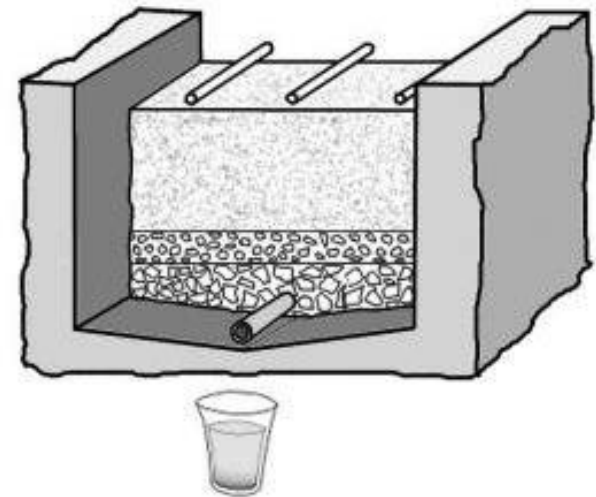
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Depending on the initial situations and respective local circumstances, there is no guarantee that single measures described in the toolbox will make the local water and sanitation system more sustainable. The main aim of the SSWM Toolbox is to be a reference tool to provide ideas for improving the local water and sanitation situation in a sustainable manner. Results depend largely on the respective situation and the implementation and combination of the measures described. An in-depth analysis of respective advantages and disadvantages and the suitability of the measure is necessary in every single case. We do not assume any responsibility for and make no warranty with respect to the results that may be obtained from the use of the information provided.



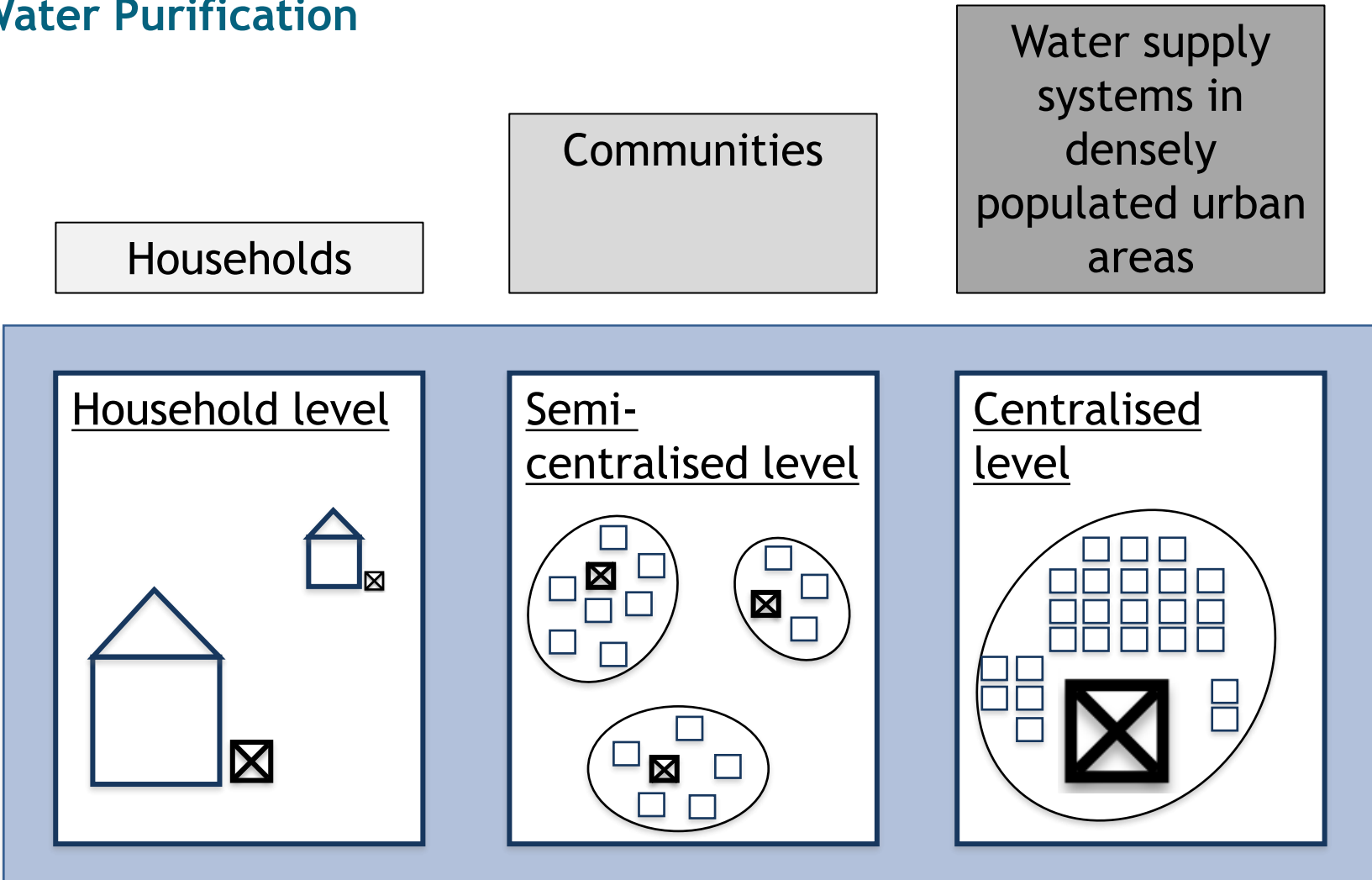
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1. Concept

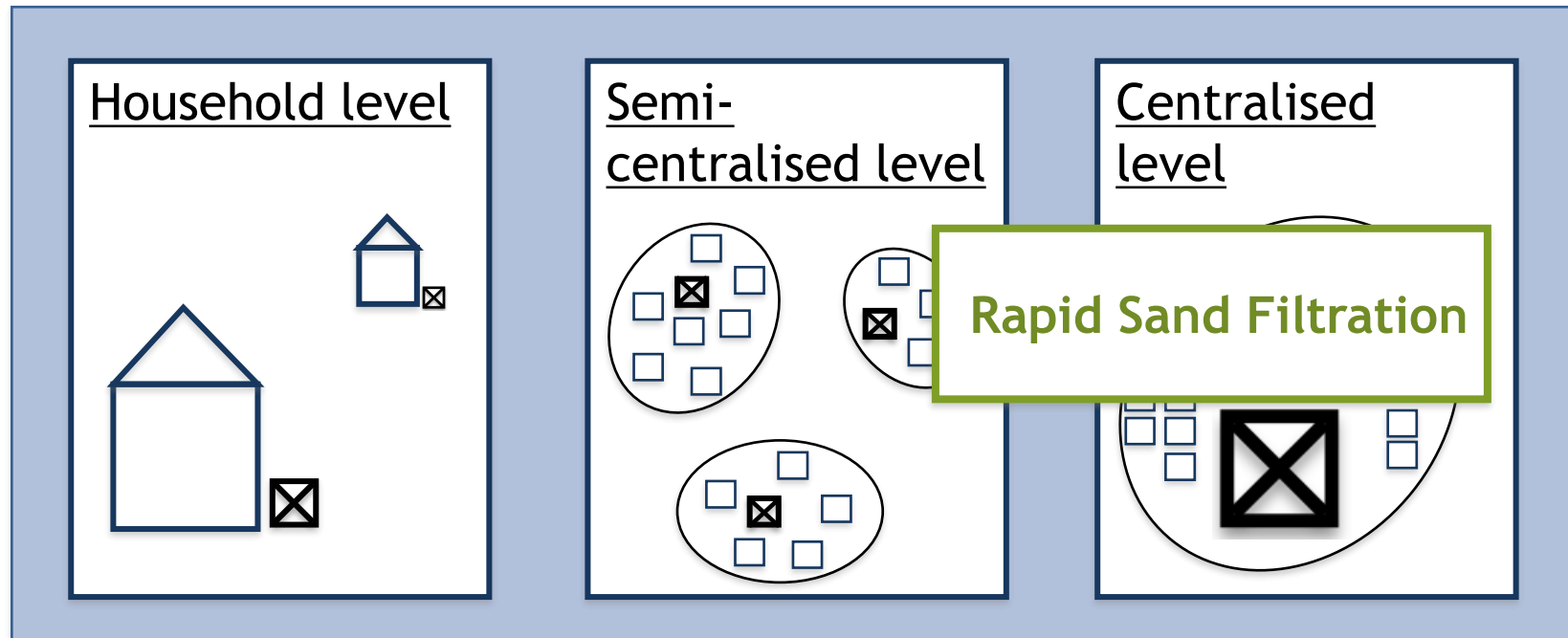
Water Purification



1. Concept

Water Purification

- **Rapid sand filtration** is a purely physical drinking water purification method on a **centralised (or semi-centralised)** level



1. Concept

Water Purification through Rapid Sand Filtration

Working Principle

After being pre-treated (coagulation-flocculation), freshwater flows through a **sand- and gravel bed**. Hereby, particles are removed through a **physical** filter process. Final disinfection.



Rapid sand filtration is an integral part of a particular water treatment procedure and cannot produce drinking-water without precedent and subsequent treatment steps.

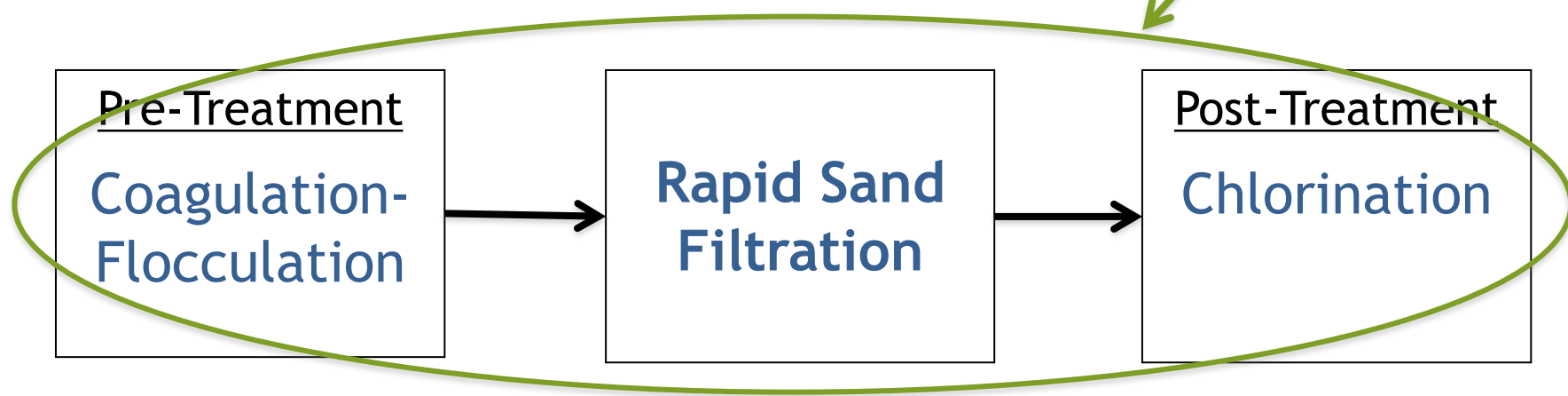
1. Concept

Water Purification through Rapid Sand Filtration

Working Principle

After being pre-treated (coagulation-flocculation), freshwater flows through a **sand- and gravel bed**. Hereby, particles are removed through a **physical** filter process. Final disinfection.

Processes are
interlinked



Rapid sand filtration is an integral part of a particular water treatment procedure and cannot produce drinking-water without precedent and subsequent treatment steps.

2. How Rapid Sand Filtration Can Optimise SSWM

Characteristics of Urbanised Areas

Large water
demand



High Land
Prices

Source: <http://headlinenewsstories.com/wp-content/uploads/2010/06/india.jpg> [Accessed: 21.02.2012]

High population
density

Limited
Space

2. How Rapid Sand Filtration Can Optimise SSWM

Water Purification in Urban Areas



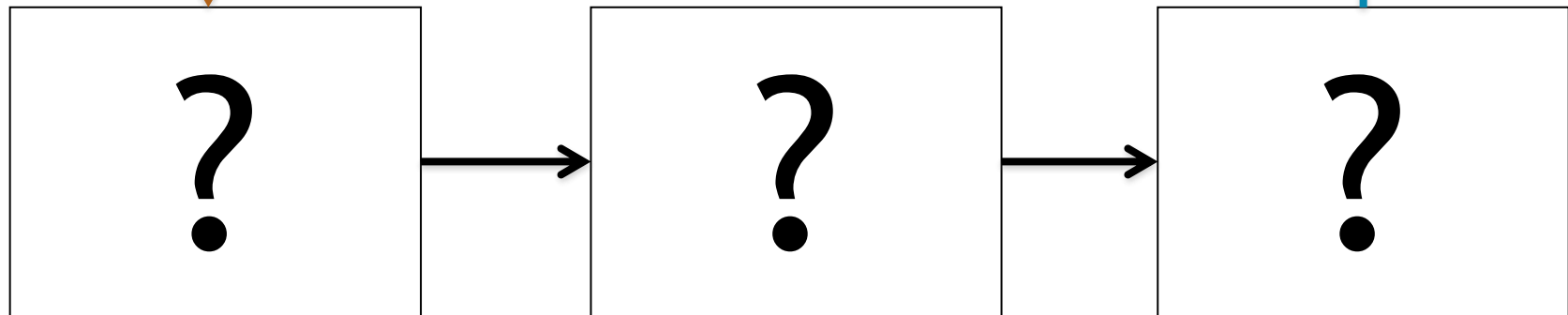
Source: <http://www.govisitcostarica.com/images/photos/full-cano-negro-brown-river.jpg>
[Accessed: 21.02.2012]



Source: <http://headlinenewsstories.com/wp-content/uploads/2010/06/india.jpg> [Accessed: 21.02.2012]



Source: <http://sinkhas1.com/wp-content/uploads/2011/07/Old-Sink.jpg>
[Accessed: 21.02.2012]



2. How Rapid Sand Filtration Can Optimise SSWM

Water Purification in Urban Areas



Source: <http://www.govisitcostarica.com/images/photos/full-cano-negro-brown-river.jpg>
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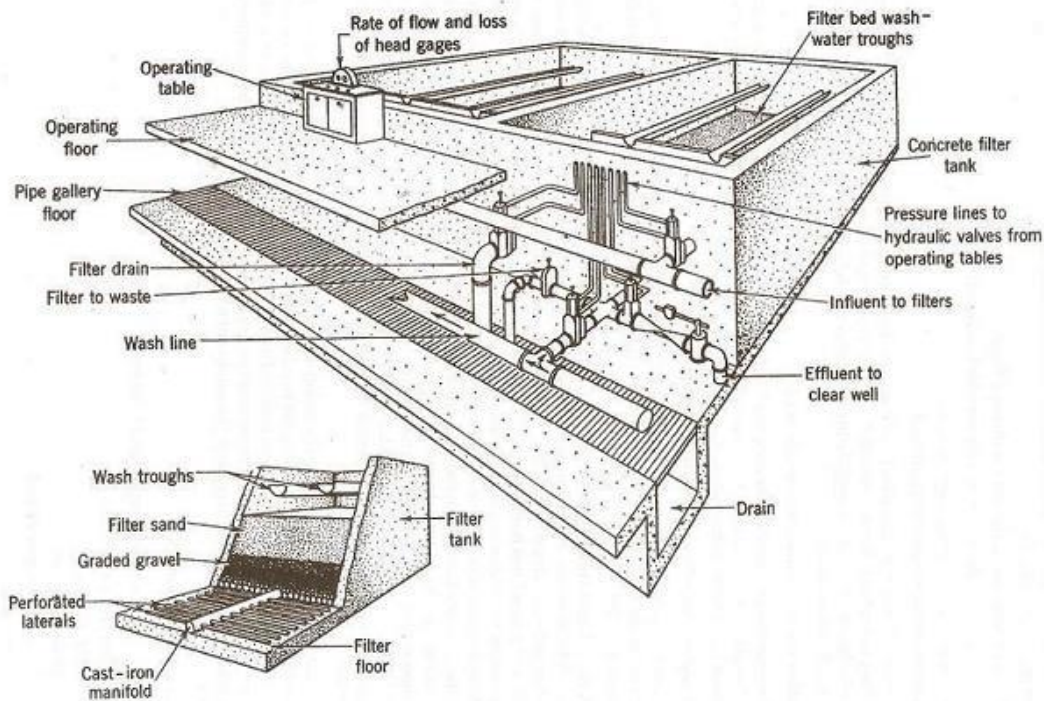
Source: <http://sinkhas1.com/wp-content/uploads/2011/07/Old-Sink.jpg>
[Accessed: 21.02.2012]



3. Design Principles

Types of Rapid Sand Filters 1/2

1. Open Rapid Sand Filters (Gravity Filter)



Source: TWT (n.y.)



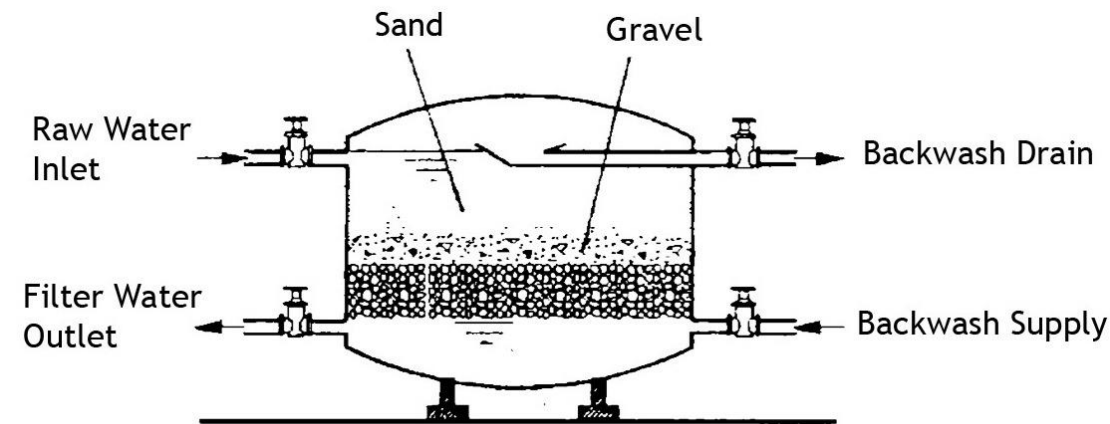
Source:

<http://img1.tradeget.com/suffuss/L191X41Q1rapidgravityfiltrationplant.jpg> [Accessed: 21.02.2012]

3. Design Principles

Types of Rapid Sand Filters 2/2

2. Closed Rapid Sand Filters (Pressure Filter)



Source: WHO (1996)



Source:

http://i01.i.aliimg.com/img/pb/532/961/244/1272335696406_hz_mylibaba_web2_545.JPG [Accessed: 22.02.2012]

4. Treatment Efficiency and Health Aspects

Efficiency versus Drinking-water Quality

Performance

4'000 - 12'000 litres per hour per m² of surface
(slow sand filter: 100 - 300 litres)

→ High rate, small land requirements



Source:

http://www.cs.iupui.edu/~momeredi/n399/bliss/images/intro_cheetah.jpg [Accessed: 21.02.2012]

Health Aspects

Moderately effective for:	Somewhat effective for	Not effective for:
<ul style="list-style-type: none"> - Turbidity - Iron, Manganese 	<ul style="list-style-type: none"> - Odour, Taste - Bacteria - Organic matter 	<ul style="list-style-type: none"> - Viruses - Fluoride - Arsenic - Salts - Majority of chemicals



Adapted from: BRIKKE & BREDERO (2003), DEBOCH & FARIS (1999), SDWF (n.y.) and WHO (n.y.)

Typical treatment performance of rapid sand filters if freshwater has been pre-treated with coagulation-flocculation

Rapid sand filtration provides safe drinking-water only in combination with pre- and post-treatment measures

5. Construction and Operation & Maintenance

Construction

- Supervision of a competent engineer and skilled workers
- Many technical installations required



Source: <http://www.schoolbuddy.de/underConstruction.gif>
[Accessed: 21.02.2012]

Construction Material

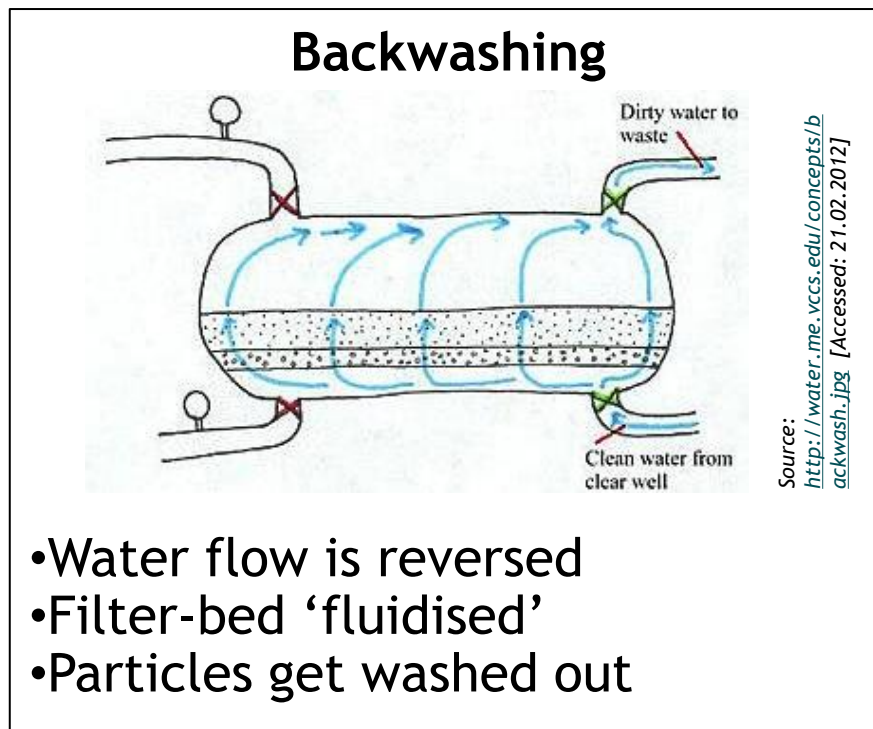
- Pumps
- (Reinforced-) concrete
- Pipes
- Valves
- Sand, Gravel
- Tools

NOTE: Construction of pre- and post-treatment facilities equally require complex working steps, expensive material and skilled workers.

5. Construction and Operation & Maintenance

O&M of a Rapid Sand Filter

- Cleaning of the filter-bed (**backwashing**) every 24 - 72 hours
- Backwashing water and sludge often toxic → Treatment required
- Skilled caretaker required



Arsenic sludge from backwashing disposed untreated into Kumar River in Bangladesh

Source: http://sos-arsenic.net/english/projectreport_images/image028.jpg [Accessed: 21.02.2012]

5. Construction and Operation & Maintenance

O&M of Pre- and Post-Treatment Facilities

- Highly skilled workers required for control and dosage of coagulants/ flocculants and disinfection with chlorine



Source: <http://www.thewatertreatments.com/wp-content/uploads/2009/01/waste-water-treatment-clariflocculator.jpg> [Accessed: 21.02.2017]

Large flocculation tank in operation

6. Applicability

Rapid Sand Filtration - a rather high-tech Solution

Prerequisites

- Availability of pre- and post-treatment facilities and material (e.g. chemicals for coagulation-flocculation, chlorine, water quality test-kits)
- Skilled supervision (both for construction and operation)
- Electricity
- Treatment facilities for backwashing water and sludge available

Main areas

- Exclusively where land is a limiting factor and electricity, spare parts and skilled labour is available

7. Advantages and Drawbacks

Rapid Sand Filtration Put in a Nutshell

Advantages:

- Very effective in removing **turbidity** / large particles (<0.1-1 NTU)
- High filter rate (4'000 - 12'000 litres per hour per m²)
- Small land requirements
- No limitation regarding initial turbidity level
- Cleaning time (backwashing) only takes several minutes

Disadvantages:

- Not effective in removing bacteria, viruses, protozoa, fluoride, arsenic, salts, odour and organic matter (unless pre- and post-treated)
- High investment and operational costs
- Frequent cleaning required (every 24-72h)
- Skilled supervision essential
- Highly energy demanding
- Treatment of backwashing water and sludge necessary

8. References

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